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Groundwater Modeling Addendum to the Response TO MDNR's Comments on the Hydrogeologic Assessment of the McGraw-Edison Site, Albion, Michigan Volume I and Volume II

March 17, 1987

Prepared by:

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Submitted to:

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First City Tower
Suite 4000
Houston, TX 77210

(0510n)

INTRODUCTION

This document was prepared as an addendum to the "Response to MDNR's Comments on the Hydrogeologic Assessment of the McGraw-Edison Site, Albion, Michigan Volume I and Volume II, dated 2/12/87. This addendum along with the main report dated 2/12/87 address all the issues raised concerning groundwater modeling from the comments of th Michigan Department of Natural Resources (MDNR) review, dated 9/29/86, of HART's "Hydrogeologic Assessment". All of MDNR's comments are addressed individually in the report dated 2/12/87. This document, addresses four main areas. First, modifications of input data are explained, followed by a discussion of the model calibration. The results of the sensitivity analysis are found in the third section of the document. Finally, a data documentation section completes this report, identifying the sources of input data to the model.

(0510n)

INPUT DATA MODIFICATION

In our effort to utilize all available lithologic data to determine the geologic conditions at the site, all lithologic data was reviewed and a discussion of the data is found as Appendix A of the "Response to MDNR's Comments" (2/12/87). The clay confining unit was then redefined, and a new clay isopach and a clay surface map was made. These maps have been included in the "Response to MDNR's Comments" (2/12/87). Details about these data sets can be found in the Data Documentation section.

The scale that was represented on the model in Volume II of the Hydrogeologic Assessment was off the true scale by 20 percent. This problem has now been corrected and the revised grid map indicating boundary conditions in the shallow and deep aquifers can be found on Figure 1.

In order to verify the new recharge rate of 11 inches per year, historical precipitation records were obtained for the last two years at Albion. Evaporation records from the nearest station to Albion at East Lansing were obtained. The available water for recharge to the subsurface area was calculated. Assumptions were drawn as to the description of area (i.e, residential, industrial etc.) in order to estimate runoff coefficients. Calculations indicated recharge values of approximately 11 inches per year.

Determination of the vertical hydraulic conductivity (VCONT) values was performed with two different methods as suggested by the Modular Model Manual (McDonald, and Harbaugh, 1984). In well defined areas of the grid where the lithology was known, the VCONT was determined by dividing the hydraulic conductivity of the clay layer by its thickness. An average conductivity value of 4.08×10^{-4} ft/day was used (DuBose, 1981). VCONT for this model takes on the units of 1/days (Spinks, 1984). In order to simplify the model, a range of thickness was utilized for the various VCONT values (Table 1). The same hydraulic conductivity measurement of 4.08×10^{-4} ft/day was utilized for all values. One area of limited

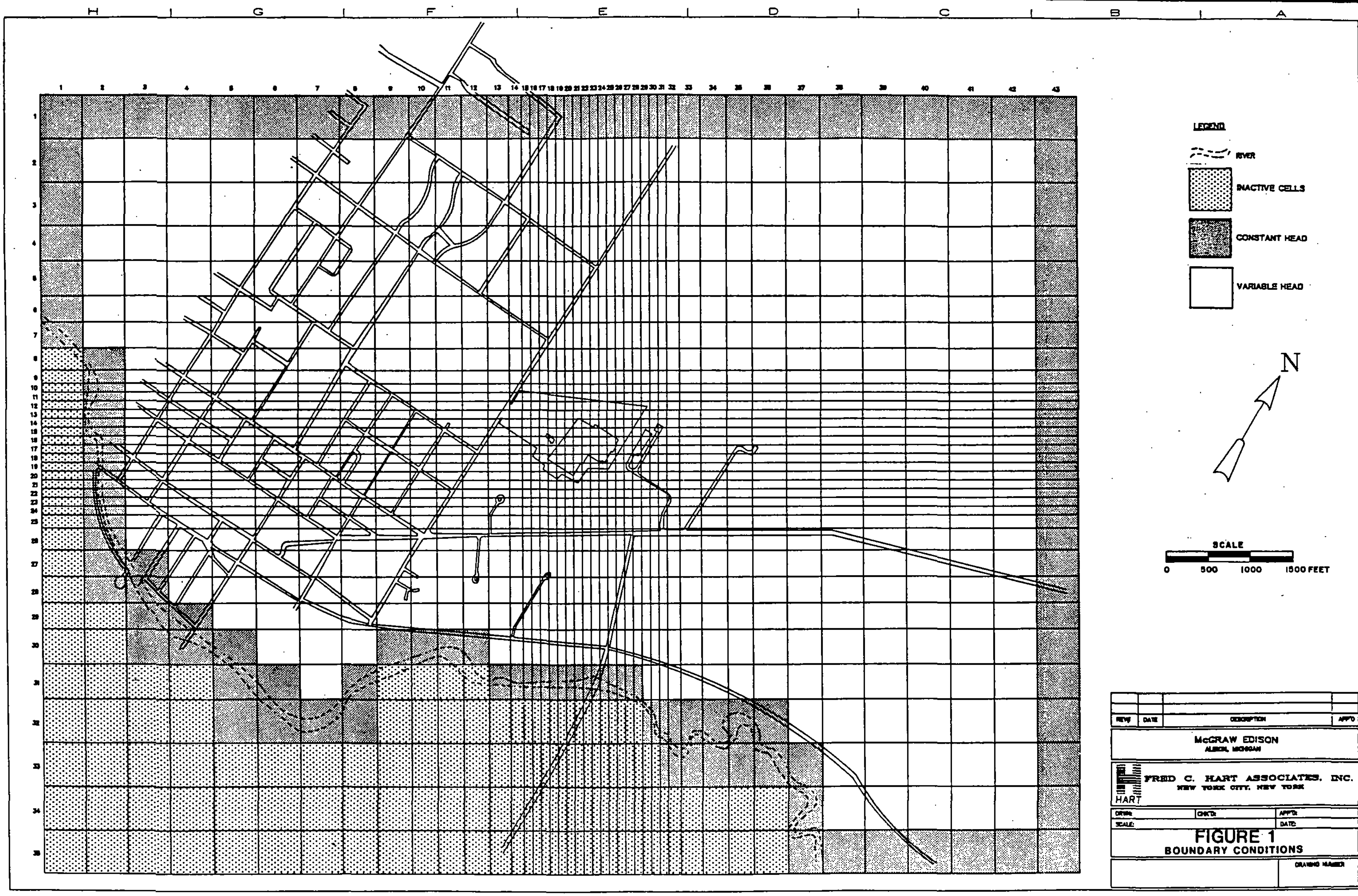

LEGEND
RIVER
INACTIVE CELLS
CONSTANT HEAD
VARIABLE HEAD
N
SCALE
0 500 1000 1500 FEET
McGRAW EDISON
ALBION, MICHIGAN
FRED C. HART ASSOCIATES, INC.
NEW YORK CITY, NEW YORK
HART
FIGURE 1
BOUNDARY CONDITIONS

TABLE 1

DETERMINATION OF VCONT VALUES

Thickness (feet)	VCONT Value (1/days)
1-2	0.0002
3-7	0.000082
8-11	0.000034
12-17	0.000027
18-23	0.00002
24-28	0.000016
29-32	0.000014
33-36	0.000011
>36	0.00001

data north-northwest of the site used the same thickness of 5 feet based on values from the boring of H-9S/D. The area to the southwest and west of the site was given the same thickness of 13 feet based on the averaging of values from wells H-10S and H-11S.

VCONT values in the window area were calculated using a different method than mentioned above. The following equation was used to calculate VCONT values in the window area for the transient runs:

$$VCONT_{i,j,k+1/2} = KV_{i,j,k+1/2} / DELV_{i,j,k+1/2}$$

Where: $KV_{i,j,k+1/2}$ = Vertical hydraulic conductivity between node (i,j,k) and (i,j,k+1);

DELV = Distance between nodes (i,j,k) and (i,j,k+1).

Assuming:

- The saturated thickness of Layer 1 is 10 feet on the average.
- Thickness of layer 2 is 300 feet.
- The conductivities in the two aquifers are the same (due to the minor effect of the conductivity in layer 1).

$$\text{VCONT of window} = \frac{70\text{ ft/day} + 70\text{ ft/day}}{2} \Big/ \frac{300\text{ ft} + 10\text{ ft}}{2}$$

$$= \frac{70\text{ft/day}}{155\text{ ft}} = .45\text{/day}$$

During calibration of the model when various hydraulic conductivities were tested, the VCONT value for the window areas was also changed accordingly.

MODEL CALIBRATION

The goal of model calibration was to approximate in the model, measurements which were gathered in the field. The techniques and procedures used in model calibration and discussed in detail in the "Hydrogeologic Assessment: Volume II" (HART, 6/27/86). This section discusses the adjustment of the various input parameters, and the ranges and sensitivities of the parameters in producing final model calibrations for steady state and transient conditions.

More than 100 model runs were performed to complete the steady-state and transient calibrations. The input parameters subject to adjustment were hydraulic conductivity, storativity, specific yield, boundary conditions, number of time steps and VCONT values. As mentioned in the previous section on Input Data Modification the new calibrations utilized the new data sets for top and bottom of the clay, recharge valves and scale.

In the steady-state calibration a range of hydraulic conductivities was run for both the shallow and the deep aquifer. Conductivities ranged from 10 to 200 ft/day and from 10 to 300 ft/day in the shallow and deep aquifers respectively. Boundaries conditions in the deep aquifer were changed to variable head. The constant head boundaries was the best approximation of the conditions measured in the field. The initial heads for steady-state conditions for the shallow aquifer are included as Figure 2. The steady-state calibrated heads for the shallow aquifer from the model have been contoured and are included as Figure 3. The initial heads for the deep aquifer and the calibrated steady-state heads are shown on Figures 4 and 5 respectively.

The calibrated steady state heads shown in Figures 3 and 5 were incorporated into the transient calibration as the starting heads. Numerous transient model runs were made varying the hydraulic conductivity, storativity, specific yield, and boundary conditions. In the transient calibration the storativity was varied from 0.0002 to 0.003 and the

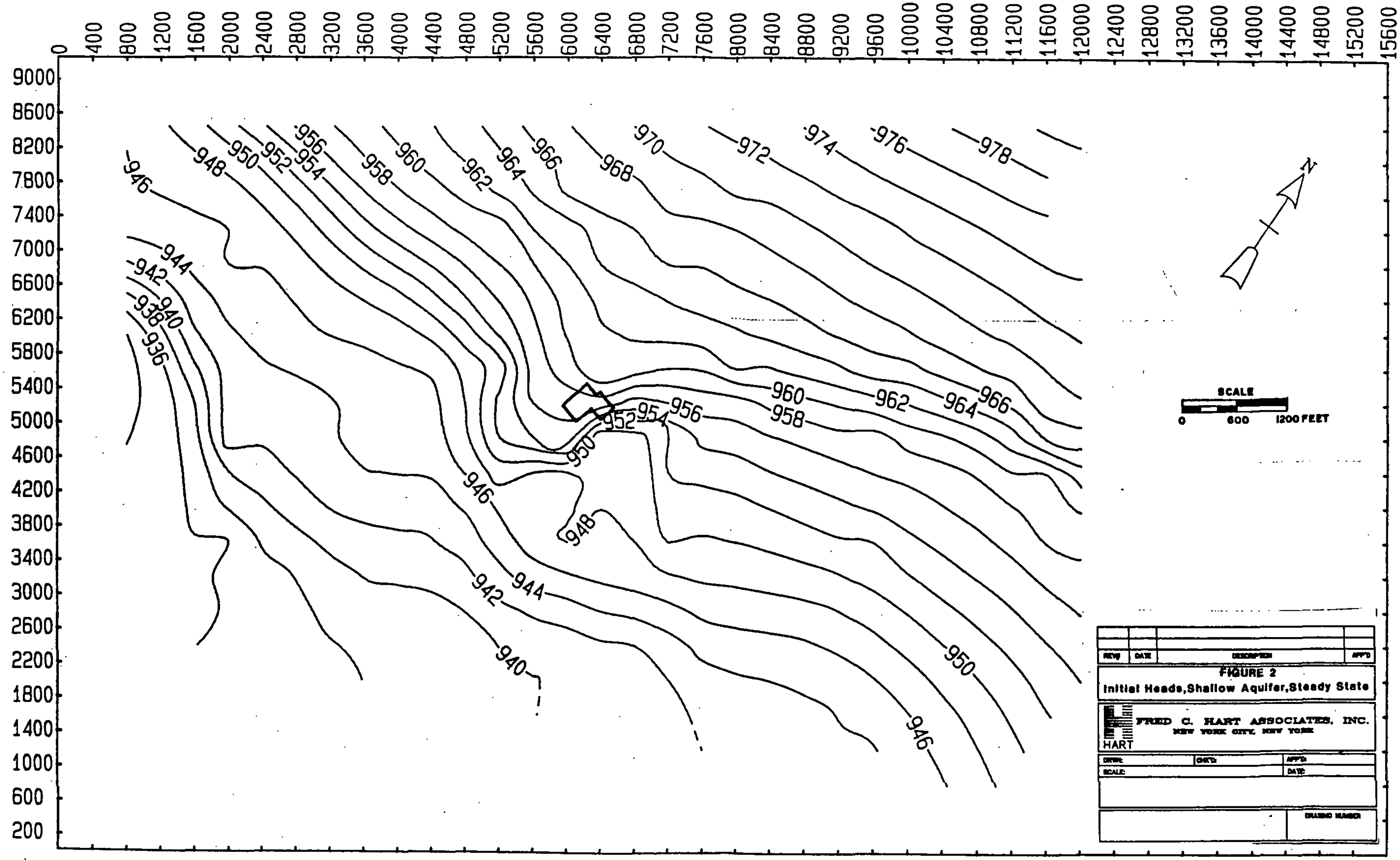
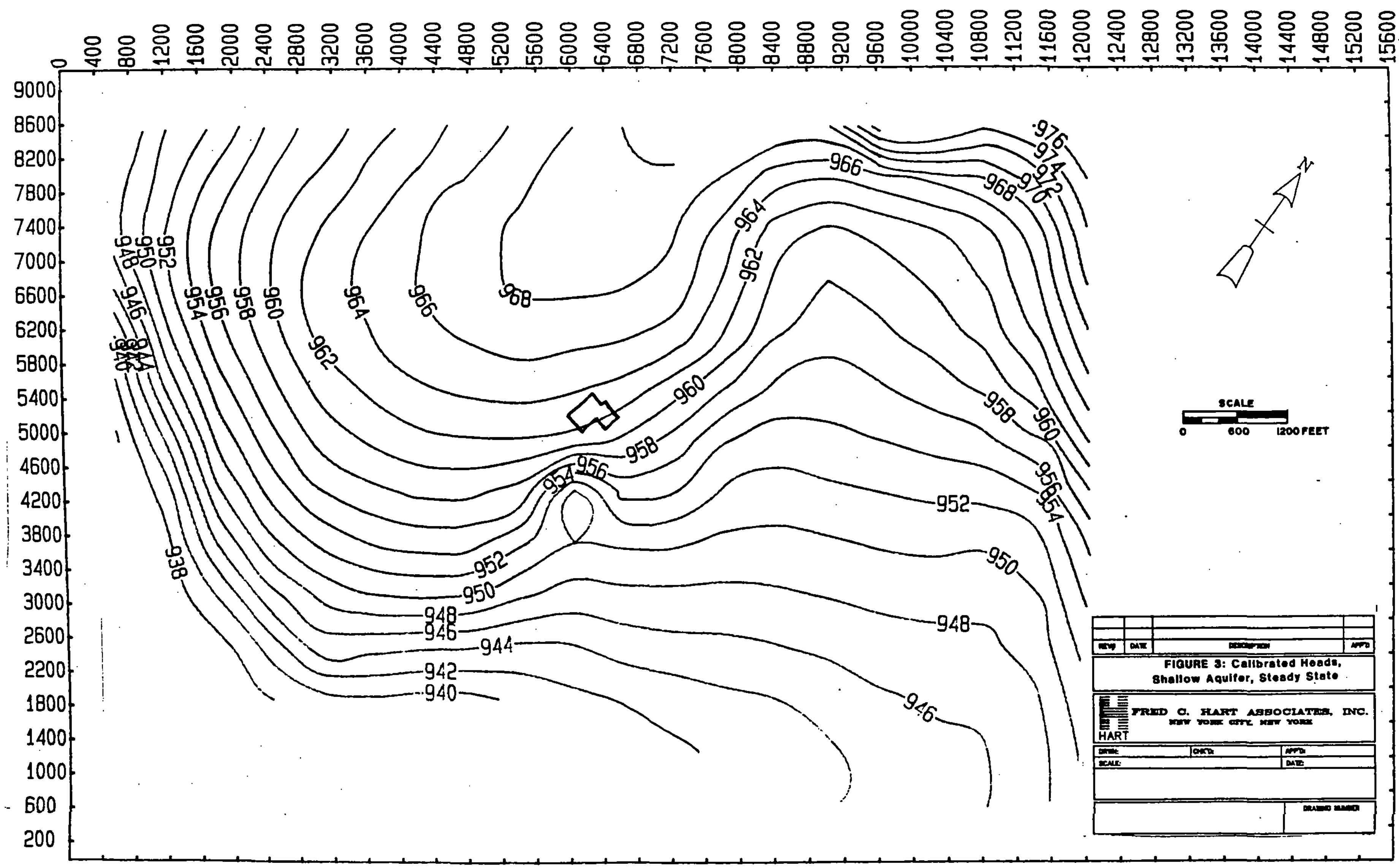


FIGURE 2
Initial Heads,Shallow Aquifer,Steady State



REV	DATE	DESCRIPTION	APP'D

FIGURE 3: Calibrated Heads, Shallow Aquifer, Steady State

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FRED C. HART ASSOCIATES, INC.
NEW YORK CITY, NEW YORK

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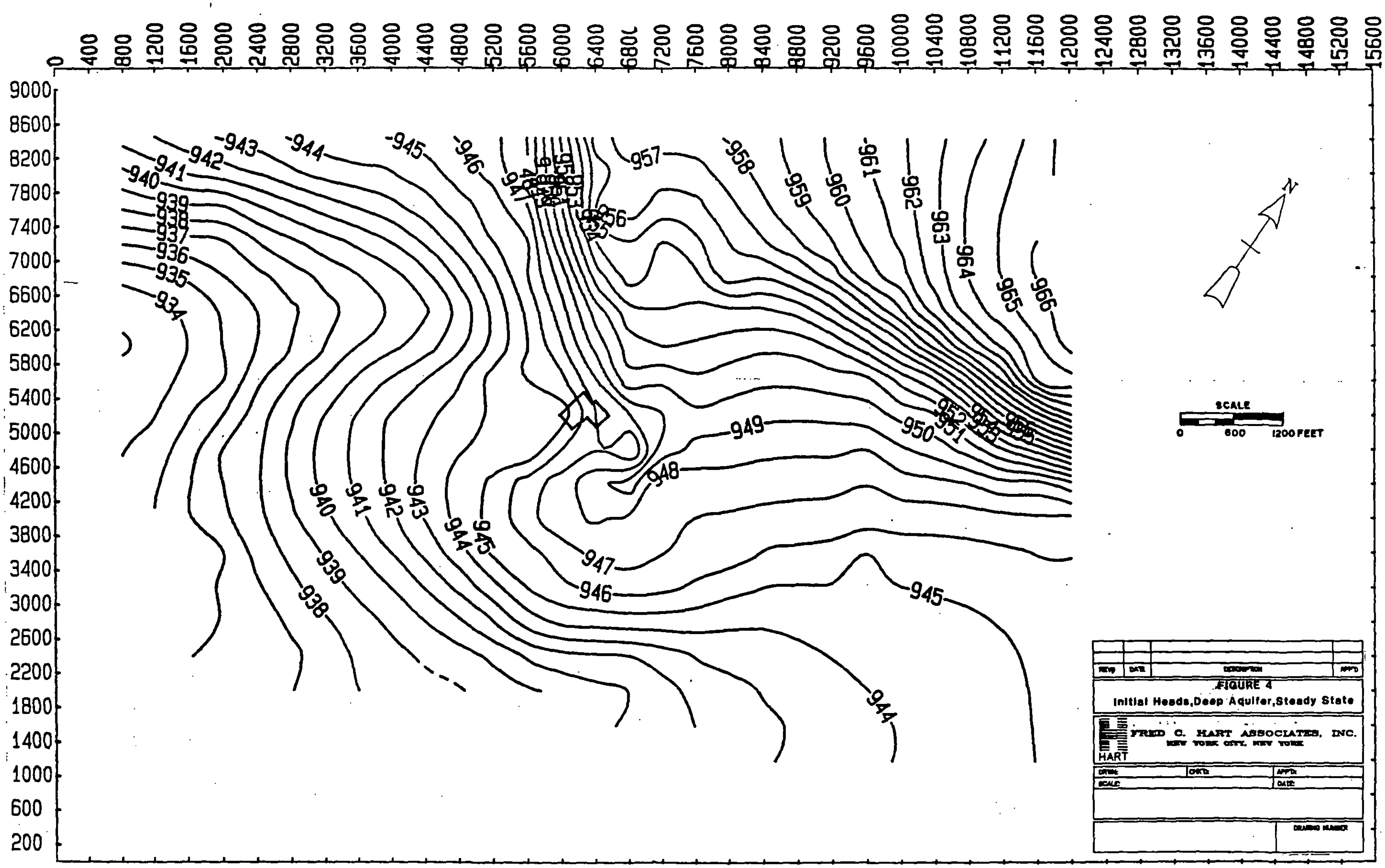

SCALE
0 600 1200 FEET
N
REV. DATE DESCRIPTION APP'D
FIGURE 4
Initial Heads, Deep Aquifer, Steady State
FRED C. HART ASSOCIATES, INC.
NEW YORK CITY, NEW YORK
HART
DRWN: CHK'D: APP'D:
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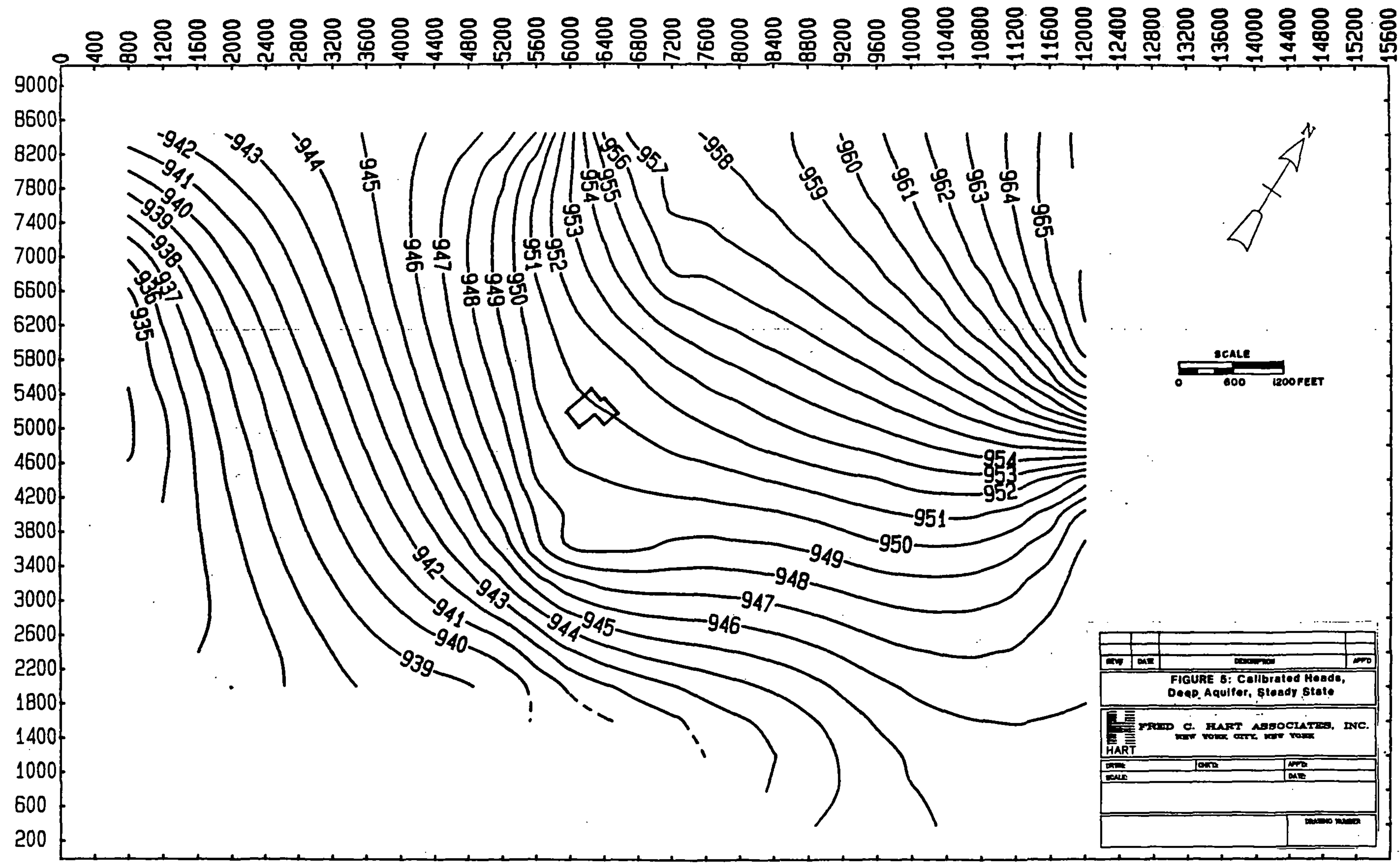


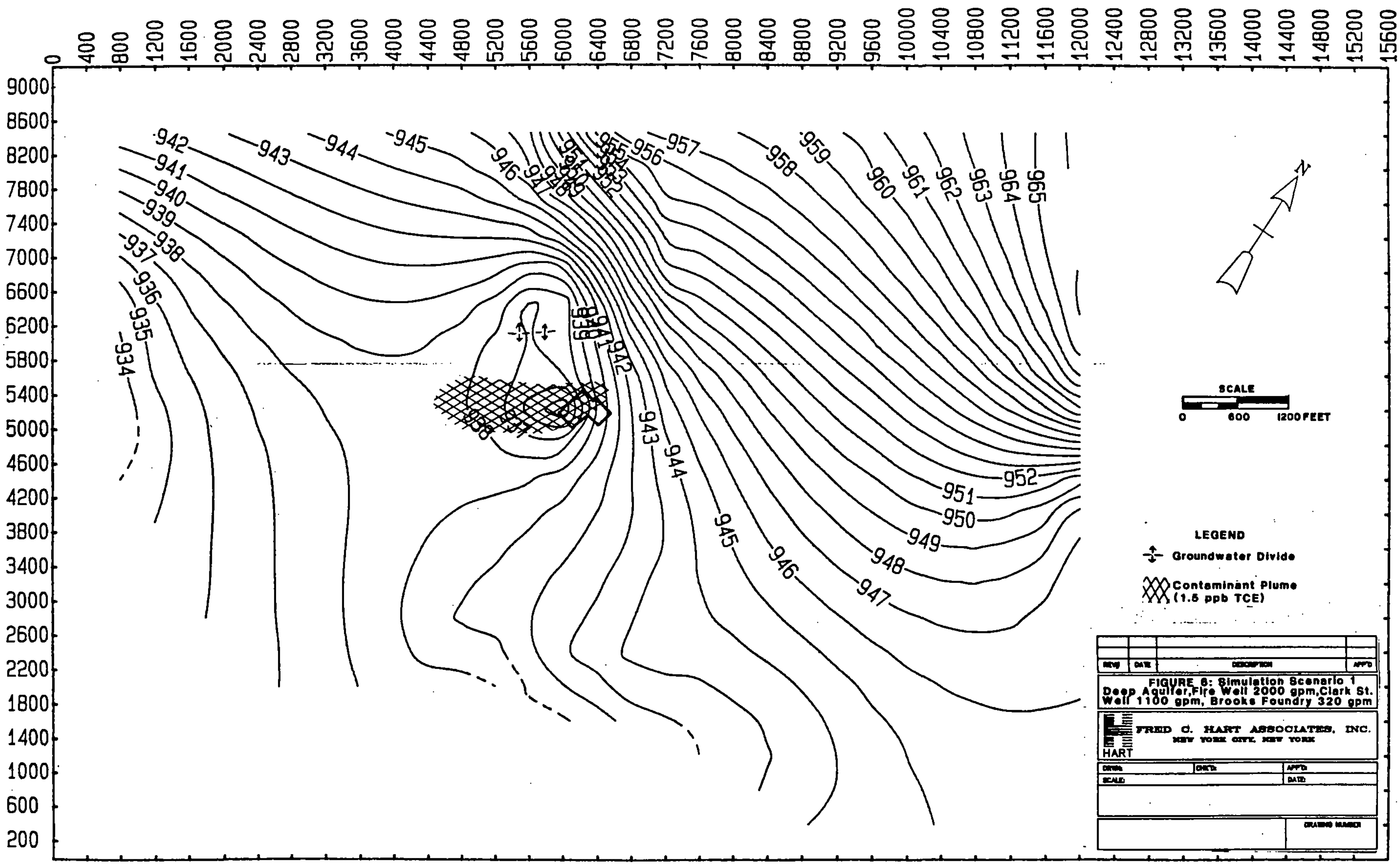
FIGURE 5: Calibrated Heads, Deep Aquifer, Steady State

specific yield ranged from 0.20 to 0.25. these parameters were found to have a minor effect on the model results. Model results were more sensitive to the changes in the hydraulic conductivity which ranged from 30 to 80 ft/day in the shallow aquifer and 10 to 200 ft/day in the deep aquifer.

Final parameters were chosen for the transient calibrations which are represented in the pumping Scenarios 1 and 2 in model output files R140 and R141 respectively. Pumping Scenario 1 depicts the Fire well pumping 2000 gpm, Clark Street well pumping 1100 gpm and the Brooks Foundry well pumping 320 gpm. The output for the deep aquifer under this scenario, is included as Figure 6. Scenario 1 approximates the actual pumping conditions at the site as shown on Figure 7. Pumping Scenario 1 agrees with the field observation that the retraction of the groundwater contaminant plume is occurring under those pumping conditions. The field observations contoured on Figure 7 also indicates that a groundwater divide is being maintained that separates the Fire well and the Clark Street well.

Pumping Scenario 2, shown as Figure 8 is a predictive scenario which indicates increased gradients toward the Fire well. The position of the groundwater divide does not change appreciably from Scenario 1, and the contaminant plume is still well within reach of the Fire well plume retraction system.

At the end of the last time step in all steady-state transient, and pumping runs, the budget discrepancy was 0.00%. At the end of the steady-state calibration and the transient calibration there are approximately 5-8% dry nodes in the shallow aquifer, out of 1505 nodes. Close analysis of these nodes indicate some areas where the top of the confining clay layer is higher than the water table surface of the shallow aquifer. Some of these dry nodes also occur in areas where there is a window in the clay layer. Limitations on the use of VCONT are noted in the program manual (McDonald and Harbaugh, 1984). The problem which we have occurs during a multilayer simulation of a single aquifer in which a well causes drawdown below the top model layer, causing some cells to



REV	DATE	DESCRIPTION	APP'D

FIGURE 8: Simulation Scenario 1
Deep Aquifer, Fire Well 2000 gpm, Clark St. Well 1100 gpm, Brooks Foundry 320 gpm

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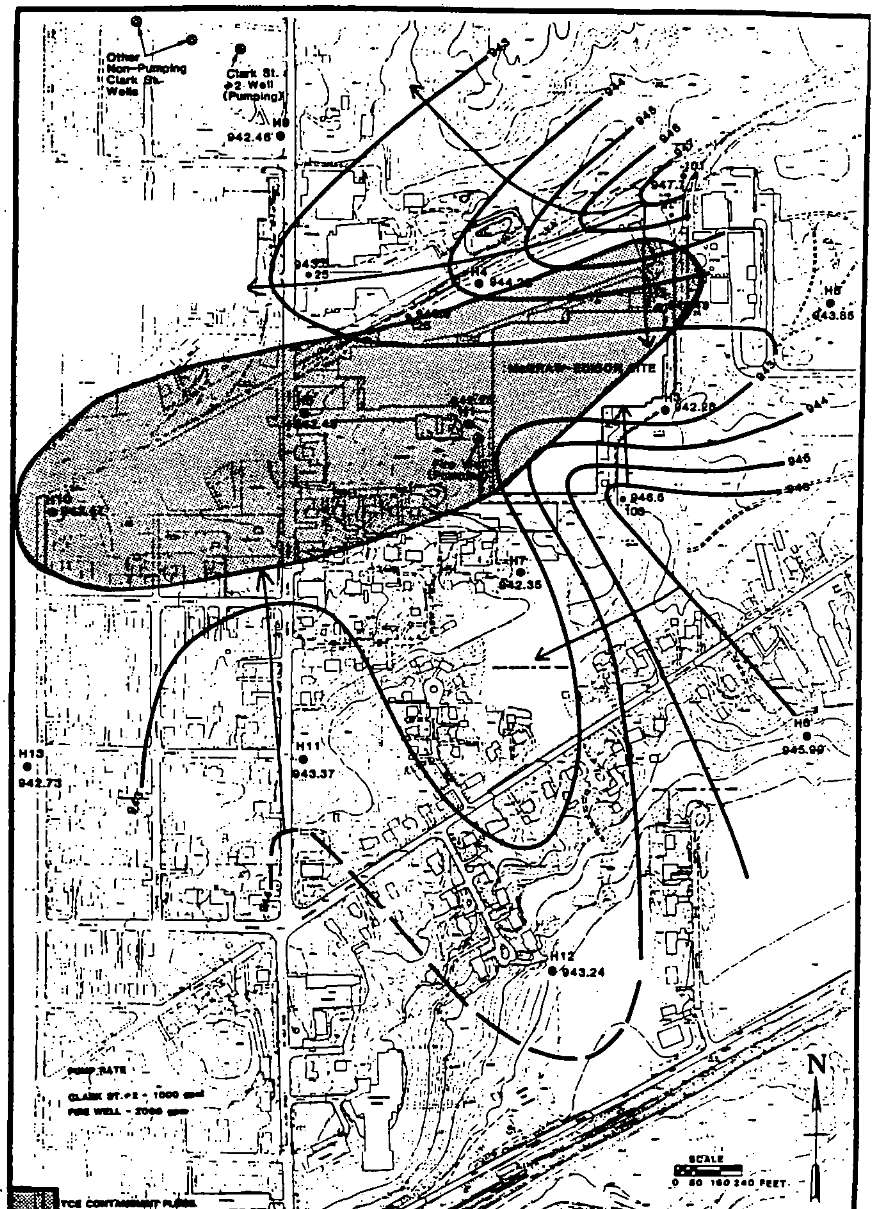
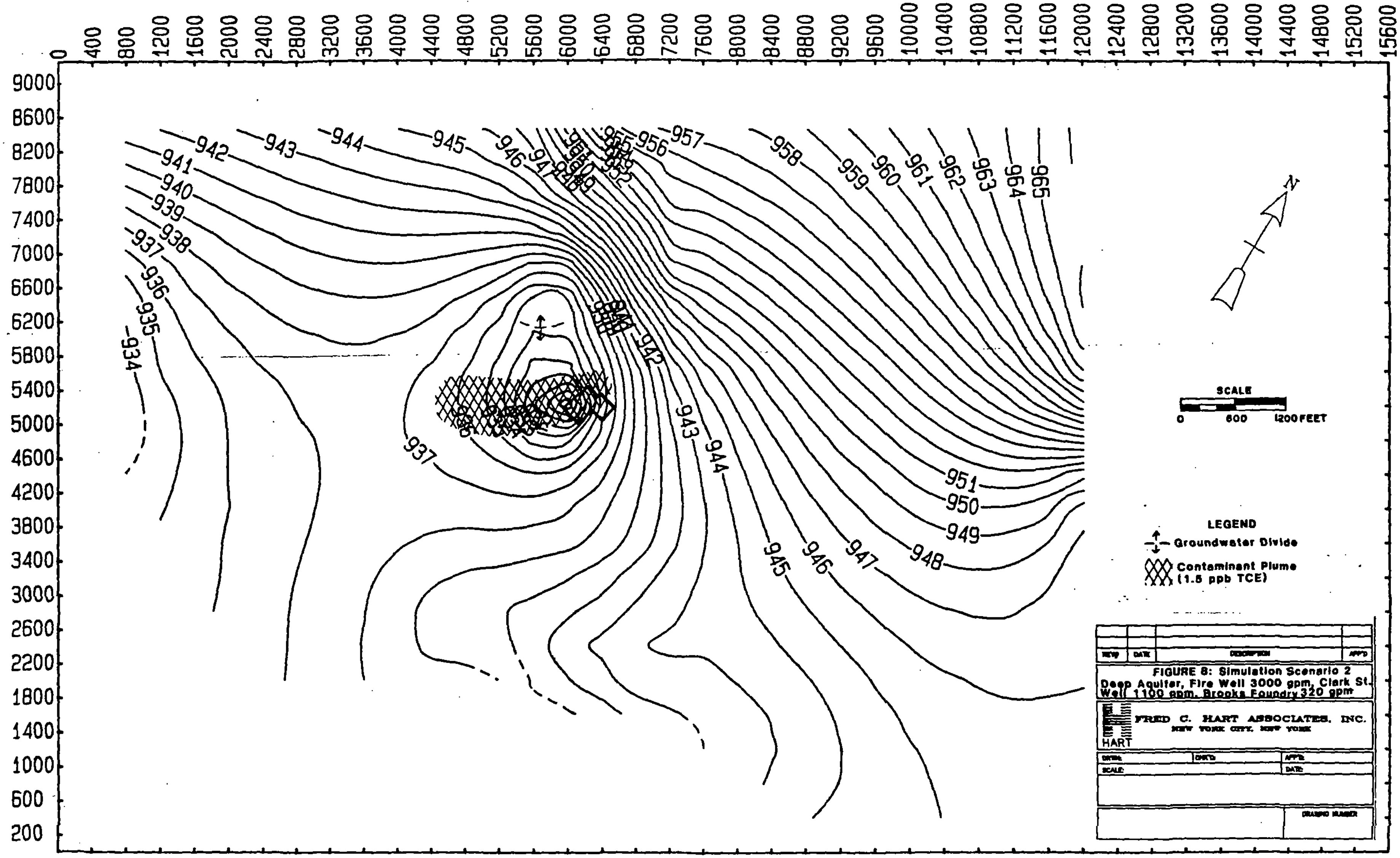


McGRAW–EDISON COMPANY ALBION, MICHIGAN FRED C. HART ASSOCIATES, INC NEW YORK, N.Y.	FIGURE 7 TCE CONTAMINANT PLUME CAPTURE CONTOUR INTERVAL: 1.0 FT.	LEGEND: ← FLOW LINE H1 ● WELL NEST NUMBER AND SYMBOL AND WATER LEVEL IN FEET —945— POTENTIOMETRIC CONTOUR LINE



SCALE
0 600 1200 FEET
LEGEND
Groundwater Divide
Contaminant Plume (1.5 ppb TCE)
REV'D DATE DESCRIPTION APP'D
FIGURE 8: Simulation Scenario 2
Deep Aquifer, Fire Well 3000 gpm, Clark St. Well 1100 gpm, Brooks Foundry 320 gpm
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NEW YORK CITY, NEW YORK
HART
DRAWING NUMBER

convert to no-flow cells sooner than they should. This has been a common problem when utilizing the USGS Modular Three-Dimensional Finite-Difference Groundwater Flow Model (Bugliosi 1987).

SENSITIVITY ANALYSIS

Sensitivity analysis showed that by far hydraulic conductivity was the most sensitive input parameter. Hydraulic conductivity was adjusted for steady-state, transient, and pumping calibrations. The final conductivity value for the shallow aquifer in calibrated pumping runs was 30 ft/day, at the low end of the 30 to 80 ft/day range indicated during the transient calibrations. The final conductivity values used in the deep aquifer ranged from 20 to 90 ft/day, again, at the low end of the 10 to 200 ft/day range indicated during the transient calibrations.

Sensitivity analyses indicated that boundary conditions are somewhat sensitive parameters. The optimal boundary conditions were achieved with constant head boundaries, for both layers, validating the initial assumption by MDNR, HART and Pinder of westerly flow in the deep aquifer parallel to the river at the river boundary. Model runs with variable head boundaries in Layer 2 at the river indicated that the cone of depression could reach further out than the cone predicted by constant head boundaries. Therefore utilizing constant head boundaries along the river provides us with a more conservative estimate of the extent of the capture zone. Actual gradients measured in the field during pumping indicate that any effect of pumping on springs on the other side of the Kalamazoo River is unlikely.

DATA DOCUMENTATION

Initial heads were specified in the model based on water level measurements taken 2/27/87. These measurements for the shallow aquifer including their locations can be found on Figure 10 of the "Hydrogeologic Assessment Volume II (HART 6/27/86)". The potentiometric surface map of the deep aquifer can be found as Figure 5-2 of the "Hydrogeologic Investigation Volume I (HART 3/21/86). River elevations have been included as Table 3 of the "Response to MDNR's Comments (HART 2/12/87)". Areas not covered by the above mentioned locations were interpolated. Data arrays HEAD100.DAT and HEAD20.DAT contain the head input data for the shallow and deep aquifers respectively. Water level measurements taken while the Clark Street well was pumping 1000 gpm and the Fire well was pumping 2000 gpm has been contoured for the deep aquifer and is included as Figure 7 of this report. Water level measurements documenting the pumping rates in Scenario 2 have not been taken. There are no measurements taken at or near the river at the times when the springs on the other side of the river were thought to have dried up.

The clay confining layer at the site was defined by a series of borings which are discussed in Appendix A of the "Response to MDNR's Comments" (HART 2/12/87). This above mentioned lithologic data was used to create a clay surface map and a clay isopach map which appear as Figures 1 and 2 respectively in the "Response to MDNR's Comments" (HART 2/12/87). The maps were interpolated to the edges of the finite difference grids. Data array BOTT1.DAT was made from the top of the clay surface map to represent the bottom of Layer 1. This clay isopach grid was then subtracted from the top of clay grid to create a bottom of the clay surface map, included as data array TOPP2.DAT.

The bottom of the deep aquifer was estimated at 600 MSL. HART performed 13 borings at the site to a depth of 300 feet, all of which terminated in bedrock. The bedrock surface at the site is approximately 900 to 950 feet MSL. This value of 300 to 350 feet in thickness is substantiated by literature indicating the Marshall Sandstone ranges between 160 and 320 feet thick in the Albion area (See, 1976).

Hydraulic conductivities in the shallow aquifer were based on laboratory tests performed at the AIRCO site adjacent to the McGraw-Edison site (Snell & Keck, 1984). Lab results indicated a range of conductivities from 1 to 25 feet per day. During model calibration a final conductivity of 30 feet/day was chosen.

A outline of model runs delineates which input modules were utilized for the various runs (Table 2). The Basic and the Block-Centered modules are described in detail in Table 3 and Table 4 respectively. All input data set and model runs are listed on Attachment 1 and can be found on disks A and B.

TABLE 2

MODEL RUNS

Figure No./ Type of Run	Basic File	Block-Centered File	Well File	Recharge File	SIP File	Output File Name
Figure 2 Initial Heads Shallow Aquifer Steady State	---	---	---	---	---	HEAD100.DAT
Figure 3 Calibrated Heads Shallow Aquifer Steady State	BAS201.INP	BLK204.INP	---	RECH100.INP	SIP100.INP	R116
Figure 4 Initial Heads Deep Aquifer Steady State	---	---	---	---	---	HEAD20.DAT
Figure 5 Calibrated Heads Deep Aquifer Steady State	BAS201.INP	BLK204.INP	---	RECH100.INP	SIP100.INP	R116
Figure 6 Simulation Scenario 1 Deep Aquifer	BAS1002.INP	BLK1006.INP	WELL1000.INP	RECH100.INP	SIP100.INP	R140
Figure 8 Simulation Scenario 2 Deep Aquifer	BAS1002.INP	BLK1006.INP	WELL2000.INP	RECH100.INP	SIP100.INP	R141

TABLE 3

STEADY-STATE CALIBRATION

BLK204.INP Components

VCONTT.DAT	°	Vertical Hydraulic Conductivity (1/day)
HYD100.DAT	°	Vertical Conductivity Layer 2 (ft/day)
BOTT1.DAT	°	Bottom of Layer 1 (MSL)
ROW.DAT	°	Cell width along rows (ft)
COL.DAT	°	Cell width along columns (ft)
Hydraulic Conductivity Layer 1	°	30 ft/day
Anisotrophy factor	°	1

BAS201.INP Components

IBOUND1.DAT	°	Boundaries, Layer 1
IBOUND2A.DAT	°	Boundaries, Layer 2
HEAD100.DAT	°	Initial Heads, Layer 1
HEAD20.DAT	°	Initial Heads, Layer 2

Length of stress period is 365 days.

TABLE 4

TRANSIENT SCENARIO 1

BLK1006.INP Components

Anisotrophy Factor	1
Specific Yield, Layer 1	0.20
Storage, Layer 2 (primary)	0.003
Storage, Layer 2 (secondary)	0.20
VCONTT10.DAT	Vertical Hydraulic Conductivity (1/day)
HYD100.DAT	Hydraulic Conductivity, Layer 2 (ft/day)
BOTT1.DAT	Bottom of Layer 1 (MSL)
TOPP2.DAT	Top of Layer 2 (MSL)
ROW.DAT	Cell width along rows (ft)
COL.DAT	Cell width along columns (ft)

BAS1002.INP Components

IBOUNDB.DAT	Boundary Conditions, Layer 1 and Layer 2
R116L1.DAT	Initial Heads, Layer 1 (MSL)
R116L2.DAT	Initial Heads, Layer 2 (MSL)

Length of Stress period is 365 days.
Time Steps: 5
Time Step Multiplier 1.5

WELL1000.INP Components*

Fire well	2000 gpm
Clark Street well	1100 gpm
Brooks Foundry well	320 gpm

*Values converted to ft^3/day

REFERENCES

Bugliosi, Edward, 1987, Communication between R. Goldman (HART) and Edward Bugliosi of the USGS in Albany, NY, March 13, 1987.

DuBose, L.A., 1981, "Hydrogeologic Study McGraw-Edison Facility Albion, Michigan," Lombard, Illinois.

Hart, F.C. Associates, 3/21/86, "Hydrogeologic Investigation Volume I, McGraw-Edison Facility, Albion, Michigan."

Hart, F.C. Associates, 6/27/86, "Hydrogeologic Assessment: Volume II, Groundwater Modeling of the McGraw Edison Facility, Albion, Michigan."

Hart, F.C. Associates, 2/12/87, "Response to MDNR's Comments on the Hydrogeologic Assessment of the McGraw-Edison Site, Albion, Michigan, Volumes I and II."

McDonald, M. and Harbaugh A. 1984, "A Modular Three-Dimensional Finite-Difference Groundwater Flow Module," US Geological Survey Open-File Report 83-875.

See, Bernie E., 1976, "Correlation of Outcrops, Jackson and Calhoun Counties, Michigan". Unpublished thesis, Albion College, Albion, Michigan.

Snell Environmental Group Inc. and Keck Consulting Services, Inc., 1984, "Results of Phase I Hydrogeologic Investigation, AIRCO Industrial Gases Facility, Albion, Michigan.

Spinks, M., 1984, "IBM PC Compatible Version of US Geological Survey Modular Three-Dimensional Finite Difference Groundwater Flow Model." Microcode Inc.

ATTACHMENT 1

DATA SETS AND MODEL RUNS ON DISK

Disk A

IBOUND1.DAT
IBOUND2A.DAT
IBOUNDB.DAT
HEAD100.DAT
HEAD20.DAT
VCONTT.DAT
VCONTT10.DAT
HYD100.DAT
HYD200.DAT
BOTT1.DAT
TOPP2.DAT
ROW.DAT
COL.DAT
R116L1.DAT
R116L2.DAT
BAS201.INP
BLK204.INP
BAS1002.INP
BLK1006.INP
SIP100.INP
WELL1000.INP
WELL2000.INP
RECH100.INP

Disk B

R116
R140
R141

Cooper Industries
P.O. Box 4446
Houston, Texas 77210

COOPER

June 24, 1992

Mr. Alan Ostrander
Michigan Department of Natural Resources
Groundwater Quality Division
Jackson State Office Bldg., 4th Floor
301 E. Louis Glick Highway
Jackson, MI 49201

Re: McGraw-Edison Site, Albion, MI

Dear Alan:

Attached please find a copy of the most recent groundwater report entitled "Summary of the March 1992 Tri-Annual Groundwater Flow and Quality Monitoring Event at the McGraw-Edison Site, Albion, Michigan." This report was generated in compliance with the requirements of the Long-Term Monitoring Program which is contained in the Stipulation and Order to Implement Final Remediation, dated July 31, 1989.

It is hoped that we can discuss the contents of this report during your scheduled site visit of July 8, 1992. Thank you for your consideration of this matter.

Sincerely,

M J O'Brien

Michael J. O'Brien
Manager, Environmental Affairs

MJO/jajun010

Attachment

cc: R.W. Teets (w/o attachment)
J.R. Sandberg (w/o attachment)
R.H. Uber (w/o attachment)

JUN 29 1992

1001 Fannin, Suite 4000
Houston, Texas 77002
713 739-5400

The purpose of this report is to allow Cooper Industries, Inc. to evaluate the information pertaining to investigations and remediation at the former McGraw-Edison site located in Albion, Michigan. Disclosure of the contents is strictly limited to those with a need to know.

SUMMARY OF THE MARCH 1992 TRI-ANNUAL GROUNDWATER FLOW AND QUALITY MONITORING EVENT AT THE McGRAW-EDISON SITE ALBION, MICHIGAN

Prepared for:

COOPER INDUSTRIES, INC.
First City Tower, Suite 4000
Houston, Texas 77210

Prepared by:

McLAREN/HART ENVIRONMENTAL ENGINEERING CORPORATION
29225 Chagrin Blvd.
Cleveland, Ohio 44122

McLaren/Hart Project No. 08-0000103-004-001

June 17, 1992

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SUMMARY OF THE MARCH 1992 TRI-ANNUAL GROUNDWATER FLOW AND QUALITY MONITORING EVENT

AT THE McGRAW-EDISON FACILITY IN ALBION, MICHIGAN

June 17, 1992

INTRODUCTION

This report details the results of the March 1992 tri-annual groundwater sampling event conducted by McLaren/Hart Engineers Midwest, Inc. (McLaren/Hart) for Cooper Industries, Inc. (Cooper) at the former McGraw-Edison site in Albion, Michigan. The sampling event was completed by a team of hydrogeologists from the Cleveland, Ohio Southfield, Michigan and Pittsburgh, Pennsylvania offices of McLaren/Hart. The study was designed to characterize groundwater quality and flow directions in both the shallow and deep aquifers at the site during the operation of the recovery wells and prior to the start-up of the soil flushing system. The stipulated wells to be measured/sampled during the operation of the groundwater recovery well/soil flushing system are listed on Tables 1a and 1b.

Overall, most of the tri-annual wells were sampled and/or water levels were measured. However, because there was no access agreement at the time of this sampling event with Mr. Hamilton Trusty and Ms. Lois Schultz to enter their properties (previously referred to as the Holtz property), no data were collected from wells on these properties. This absence of data has made the interpretation of groundwater flow directions and contaminant plume configurations incomplete in both the shallow and deep aquifers.

A comparison was made between the March 1992 chemistry data and historic chemistry data from 1984, 1986, 1988, 1990 and 1991. Those possible affects of the recovery well/soil flushing systems which were noted in the comparison are reported in this document.

GROUNDWATER LEVEL MEASUREMENTS

Groundwater levels were measured in the monitoring wells with an electronic water level indicator to an accuracy of +/-0.01 feet. These depth measurements were converted to groundwater elevations using top of casing elevations. Top of casing elevations were surveyed by McLaren/Hart in March of 1988 and by Davis Land Surveying on August 14, 1991. All groundwater level information from the baseline sampling event is listed in Table 2 (shallow aquifer), Table 3 (deep aquifer) and Table 4 (wells associated with the recovery system.) These tables also contain remarks on the condition of the wells at the time the groundwater level measurements were made and include recommendations for their rehabilitation. Monitoring well locations are shown on Figures 1 and 2.

Groundwater levels were not measurable in some wells due to damage or inaccessibility (Refer to Tables 2, 3, and 4 for details). Of particular concern was the lack of access to the monitoring wells located on the properties of Mr. Hamilton Trusty and Ms. Lois Schultz. Groundwater level measurements were not taken in recovery wells, since some of these wells may cycle on and off during operation and thus could yield data of questionable value.

The groundwater levels were used to prepare potentiometric surface maps and to delineate groundwater flow directions for both the shallow and deep aquifers. Figure 1 illustrates the potentiometric surface of the shallow aquifer on March 23, 1992. As indicated, a general flow direction to the southeast is present in the shallow aquifer from the McGraw-Edison site toward the Trusty and Schultz properties, and is similar to groundwater flow patterns mapped in previous studies. Shallow groundwater along the western edge of the property flows in a southwesterly direction. Figure 2 illustrates the potentiometric surface of the groundwater in the deep aquifer on March 23, 1992. Figure 2 also illustrates the influence of pumping the fire protection well (pumping at about 2,000 gpm). Water level elevations indicate that the direction of groundwater flow in the deep aquifer near the plant is toward the fire protection well. It appears that a groundwater divide is being maintained in the deep aquifer between the fire protection well and the Clark Street municipal well field. The groundwater flow directions in both the shallow and deep aquifers could not be accurately mapped for areas beneath the Trusty and Schultz properties.

Previous studies have indicated the absence of clay confining layers separating the shallow and deep aquifers beneath the Trusty & Schmidt properties. These clay confining layers were mapped in both lateral and vertical extent during those studies and were found to be present in varying thicknesses and at varying depths throughout most of the study area. These clay layers tend to act as a confining unit, perching groundwater in the shallow sand unit overlying the clay layer. This is most evident in the northern and western areas of the site which have higher groundwater levels. Groundwater levels drop significantly at the southeastern edge of the facility adjacent to the Trusty and Schmidt properties where the clay is reported to be absent, and the bedrock aquifer appears to be recharging. This area also contains the thickest sequence of coarse well sorted sands which support the highest well yields by recovery wells.

Shallow aquifer monitoring wells H-7s, B-102d, P-3B, and P-7B were not used in the construction of the potentiometric surface map. These wells were excluded because they are completed in a sand unit located below the confining clay layer. The levels in these wells more closely correlate with the deep aquifer water levels since they are hydrologically connected to the underlying sandstone.

Monitoring wells P-3B and P-7B are nested with wells P-3 and P-7, respectively. A considerable hydrologic head difference was noted between the shallow and deep wells completed in the glacial drift in both sets of nested wells. A negative head difference (downward gradient) of -11.13 feet was noted in the P-3 nest of wells and a negative head difference of -11.37 feet was noted in the P-7 nest of wells. Minor negative head differences were also noted at nested sets of monitoring wells P-16 (-0.72 ft.) and P-19 (-0.17). The negative head differences indicate that the lower sand unit in the glacial drift aquifer is recharging the sandstone bedrock along the line of recovery wells 1A to 15A and piezometers P-1 through P-19. A positive head difference (upward gradient) was noted in nested sets of monitoring wells along the eastern line of recovery well (+0.10 ft. at P-21, +0.24 ft. at P-24, +0.63 ft. at P-27, +0.36 ft. of P-30, and +0.72 ft. at P-33). This positive head difference appears to be related primarily to the spacing of the two wells in relation to the pumping recovery well. The nested well closest to the pumping well has a lower water level than the well located ten (10) feet away.

GROUNDWATER SAMPLING

Fourteen (14) of the fifty-one (51) wells listed in the long-term tri-annual groundwater monitoring program could not be sampled during this sampling event. Samples from thirteen (13) wells were used as alternatives to fill in some data gaps and to replace samples from these fourteen wells. Monitoring wells H-12s and B-48s were dry. Water samples were collected from wells H-13s and B-46s as alternates. Monitoring wells H-3s, H-3d, B-102s, and B-125d could not be sampled due to damage to these wells, and B-125s remains to be drilled. Alternate wells were sampled as replacements for three (3) of these wells. These alternate wells were P-16 for H-3s, P-16B for H-3d, and B-115s for B-102s. There were no suitable alternate monitoring wells for wells B-125s and B-125d. Water samples were collected from the nested monitoring wells P-3/P-3B, P-16/P-16B and P-19/P-19B to assess performance of the flushing recovery well system and to assess vertical stratification of contaminants. Monitoring wells B-33d, B-40s, B-40d, B-43s, B-43d and B-44d could not be sampled since, at the time of the sampling event, no access agreement existed with the private land owners. Monitoring wells B-28s and B-32s were sampled as the only possible alternative wells for the wells on the Trusty and Schultz properties.

Each well sampled for groundwater quality was purged and sampled on the same day. Three well volumes were purged from each well using either a dedicated purging/sampling device (bladder pumps or dedicated teflon bailers), stainless steel bailers, or a portable submersible pump (Fultz Pump). The determination of the volume of water to be purged in each well was computed using water level measurements and records of total well depths. In the event that a static water level could not be measured in a well (H-6s), the static water level at the time of well installation was used to determine the required purge volume.

All wells that did not contain dedicated sampling devices were purged and then sampled using a stainless steel bailer. A new length of bailer cord was used at each well and the bailers were disassembled and decontaminated prior to and after sampling each well. These measures were taken to prevent cross contamination during sampling. Compressed nitrogen was used to operate the bladder pumps (Well Wizards).

Each groundwater sample was placed in a set of four laboratory prepared 40 ml glass vials. Each vial was capped with a lid containing a teflon septa and contained hydrochloric acid (HCL) preservative. The conductivity, pH, and temperature of the groundwater from each well were measured in a separate container in the field and recorded. Sample bottles were sealed in plastic bags and immediately preserved in a cooler of ice. Strict chain-of-custody procedures were followed from the time of sample collection vials were shipped from the lab, through their delivery to the laboratory, and the receipt of results. All sealed coolers containing the groundwater samples were shipped by overnight courier to Savannah Laboratories & Environmental Services, Inc., in Savannah, Georgia.

Quality control samples and blanks were also submitted to the laboratory along with the groundwater samples. A trip blank was included with each cooler of samples submitted to the laboratory for analysis. This blank was prepared by the laboratory and was present with the sample bottles during shipment from the laboratory to the site and back to the laboratory. This blank was analyzed for the purpose of evaluating potential contamination by the environments to which the bottles had been exposed. Two blind duplicate samples with false well identifications were sent to the laboratory to test the reproducibility of analytical results (H-14s from monitoring well H-8d and H-14d from monitoring well H-5s). All quality control samples were analyzed for the same parameters as the groundwater samples.

DECONTAMINATION PROCEDURES

All groundwater level measuring, purging and sampling equipment used at the site was decontaminated prior to and after use. This decontamination was necessary to prevent cross-contamination between sample locations. Decontamination was not required for sampling equipment in wells containing dedicated sampling devices (bladder pumps and teflon bailers).

The following procedure was used to decontaminate stainless steel bailers: 1) the bailer was disassembled and all parts were washed with a solution of laboratory grade detergent, and 2) this wash was followed by rinses of distilled water, methanol, and a final distilled water rinse, and 3) the bailers were allowed to air dry following reassembly and then wrapped in aluminum foil.

The outer surface of the Fultz Pump and the associated teflon tubing were washed in the detergent water solution and rinsed with distilled water. In addition, the interiors of the Fultz Pump and associated tubing were cleaned by pumping the detergent water solution and then a distilled water rinse through the pump and teflon tubing.

LABORATORY ANALYTICAL CHEMISTRY RESULTS

All groundwater samples were analyzed for the purgeable trichloroethylene (TCE) using EPA method 601 (from SW-846). The laboratory's performance with respect to holding times, method blanks, matrix spike and matrix spike duplicate recoveries and surrogate recoveries was reviewed, as well as the results of McLaren/Hart quality control samples (trip blanks and blind duplicates).

The laboratory results for all groundwater and quality control samples are listed in Tables 5 and 6. Table 5 contains results from shallow aquifer samples and Table 6 contains results from the deep sandstone aquifer. The notation "ND" denotes that TCE was not detected at the method detection limit (<1.0 ppb). All of the data reported by the laboratory and the chain-of-custody forms are contained in Appendix III.

Validated analytical results were used to prepare maps of the TCE plumes at the McGraw-Edison site, Figures 3 and 4. These plume maps, in conjunction with potentiometric groundwater surface maps, illustrate the conditions at the site in March 1992.

Figure 3 is an illustration of contoured TCE concentrations in the shallow aquifer as indicated from the March 1992 analyses. TCE concentrations were, as expected, greatest (up to 2200 parts per billion (ppb)) in the vicinity of B-124s which is located in the central part of the extraction well system and adjacent to flushing area A. The 100 ppb isoconcentration line extends onto the Airco property to the east, the treatment building to the west, and to the area beneath the existing building. The isoconcentration contour lines are estimated in the vicinity of the Trusty and Schultz properties due to the absence of data from those wells.

A TCE concentration of 14 ppb was measured in monitoring well H-6s. This value was not used in constructing the TCE plume contours. This well has historically had TCE levels below a detection limit of 1 ppb. Drawing the 10 ppb and 1 ppb to this point could not be justified given the distance (900 to 1100 ft.) to the closest wells which were monitored.

Figure 4 is an illustration of contoured TCE concentrations measured in groundwater from the deep sandstone aquifer. The highest TCE concentrations (240 ppb) were reported in well B-103d, near the southeast corner of the plant. This is in the area where the clay confining layer which separates the shallow and deep aquifers is absent. This observation supports the previous interpretation that contaminants are entering the deep aquifer from the shallow aquifer south and east of the plant. The outermost isoconcentration line on Figure 4 is the 1 ppb contour. The extent of the plume is only estimated to the southeast of the plant because of the absence of data from the Trusty and Schmidt property wells.

The laboratory analytical chemistry results from nested monitoring wells P-3/P-3B, P-16/P-16B and P-19/P-19B were compared to evaluate vertical movement and segregation of the TCE contamination. Results of this evaluation indicates that there is a vertical stratification of TCE concentrations in different sand units within glacial drift soils. In all but one nested well site, P-19/P-19B, the concentrations of TCE were higher in the lower of the two wells. At the P-3/P3B site, the upper well, P-3, had a TCE concentration of 91 ppb and the lower, P-3B, had 130 ppb. This nest of wells is located along the southern line of recovery wells. The upper and lower wells at this site are tapping different sand units in the glacial drift soils. These sand units are separated from one another by confining or semiconfining clay and silt rich unit. The nested wells along the south side also show a lower hydraulic heads in the lower sand units than in the upper sand unit, which indicates that the two sand units are hydraulic separated by a confining or semiconfining layer. The higher concentrations of TCE in the lower sand unit may be indicative of contamination being drawn back on to the site by the combined influence of pumping the Fire Protection well which is completed in the underlying sandstone and the new shallow aquifer wells (1A through 11A) which tap both the upper and lower sand units.

The concentrations measured in the nested monitoring wells P-16/P-16B were 500 ppb and 620 ppb, respectively. These wells are located downgradient of flushing area A and are not completed in hydrologically separated sand units (There is no confining clay layer between the screened interval in each well). A relatively small negative head difference (-0.72 ft.) exists between the upper and lower well at this site.

The concentrations of TCE observed in the nested wells P-19/P-19B (250 ppb and 2.1 ppb, respectively) shows a significant difference with the lower well showing a much lower concentration of TCE. This lower concentration of TCE in P-19B may be indicative of a dilution by clean groundwater from a lower sand unit. This lower sand unit is separated from the upper sand unit in this area by a clay layer. The source of recharge for the lower sand unit may be to the east where neither the McGraw-Edison and/or Airco operations have affected groundwater quality.

DISCUSSION OF HISTORICAL TRENDS

Concentrations of TCE reported in 1984, 1986, 1988, 1990, and 1991 for the shallow and deep aquifers were tabulated and compiled along with the March 1992 data and are listed in Tables 5 and 6. These tables were compiled to evaluate the historical trends related to TCE concentrations in groundwater. The 1984 through 1991 data were collected during the period in which the groundwater recovery wells and treatment system has been operating, but prior to the initiation of the soil flushing system. The March 1992 sampling event is the first sampling which follows the initiation of the flushing system in August and September of 1991.

There are forty-three (43) shallow aquifer monitoring wells with TCE values reported in Table 5. Twenty-one (21) of these wells showed a decrease in TCE concentration and six (6) wells showed upward and downward variations in concentration prior to this sampling. Only four (4) wells showed an increase in TCE levels with time prior to initiating flushing. TCE was never detected in three (3) wells and nine (9) wells had only one sampling, so that no trend evaluation was possible. The increases in TCE concentration in wells B-38d, B-40s and B-43s may not reflect a trend which has progressed to the present, since these wells are located on Trusty and Schmidt properties and could not be sampled in 1990 and 1991. The most significant decreases in TCE concentrations in the shallow aquifer occurred along the eastern edge of the McGraw-Edison property, where the extraction well system has been operating (wells H-2s, H-3s, and B-31s). Wells north, south and west of the extraction well system have shown steady decreases, although of lesser magnitude. Wells H-1s, B-29s, B-110s, B-124s, P16, and P-16B are adjacent to flushing areas and all showed some increase in TCE levels over the baseline levels. Future sampling events during 1992 will more closely define the effects of flushing.

There are twenty-six (26) deep aquifer monitoring wells with TCE values listed in Table 6. Fifteen (15) of these wells have shown a decrease in TCE concentrations and three (3) wells have shown upward and downward variations in concentration prior to the initiation of flushing. Five (5) wells have never had TCE reported in water samples. Only three (3) wells have shown increases in TCE concentrations (H-6d, B-28d and possibly B-43d). The increased concentration in B-28d and B-43d may be due to the drawing of TCE back onto the site by the pumping of the fire protection well. The greatest reductions in concentrations has been in wells B-45d, B-109d and possibly B-40d and B-125d. Wells H-10d, H-8d, B-110d, H-9d, and B-47d have shown a steady decrease in concentrations down to levels below detection limits.

CONCLUSIONS

Overall, the objectives of the March, 1992 groundwater sampling event at the former McGraw-Edison facility have been met. The groundwater flow directions in both the shallow and deep aquifers have been generally defined. Groundwater flow conditions in the southeastern part of the study area were estimated, due to an absence of data from the Trusty and Schultz well properties. It appears that the groundwater divide in the deep aquifer between the site and the Clark Street municipal well is being maintained through the pumping of the on-site fire protection well.

The extent and configuration of the TCE plumes has also been generally defined in both the shallow and deep aquifers. Again, the absence of data from the Trusty and Schultz well properties necessitates the estimation of the plume configurations in the southeast part of the study area.

Principal findings of the March, 1992 tri-annual monitoring event baseline study are summarized as follows:

- Groundwater flow in the shallow aquifer is to the southeast, possibly influenced by leakage of groundwater from the shallow aquifer into the deep aquifer where the clay aquitard is absent. This flow also may be influenced by the high yields from recovery wells 14A, W-3, 15A, 16A, and 17A in this area.

- Groundwater flow in the bedrock aquifer is generally to the west but exhibits localized variations due to pumping wells and other influences. The mound of groundwater in the south (although based on limited data) may be associated with recharge to the bedrock aquifer from the shallow aquifer and the Kalamazoo River in that area. A drawdown cone has been established in the vicinity of the on-site fire protection well. The city's Clark Street supply well is located upgradient and thus, an apparent groundwater flow divide exists between the site and the cities well field.

- Maximum TCE concentrations in the shallow aquifer are on the order of 2200 ppb, and are adjacent to flushing area A (which has the highest levels of soil contamination). In the deep aquifer, a maximum TCE concentration of 240 ppb occurs at the southeastern corner of the property (in well B-103d). The TCE in the deep aquifer may be from the shallow aquifer which is recharging the deep aquifer in this area.

- The higher concentration of TCE in the lower well in nested well sets along the southern line of recovery wells may indicate that the new deeper recovery wells in this area are drawing contaminated groundwater back onto the site.

- The effects of flushing cannot be fully assessed at this time since this is the first sampling event following the initiation of period of flushing. However, increased TCE concentrations were measured in some shallow and deep aquifer monitoring wells adjacent to the flushing areas. This appears to indicate that the increased TCE concentrations are due to the flushing of the contaminated soils. Future sampling during flushing system operation will more fully define the effects of the flushing system.

Table 1a. Monitoring Wells Required Under the Long-Term Groundwater Monitoring Program at the McGraw-Edison Site Albion, Michigan

TRI-ANNUAL SAMPLING

(Water Levels and Chemistry Sampling Tri-Annually)

Shallow Wells	Bedrock Wells Interface Wells	 Deep Wells
H-1S		H-1D
H-2S		H-2D
H-3S		H-3D
H-4S		H-4D
H-5S		H-5D
H-6S		H-6D
H-7S		H-7D
H-8S		H-8D
H-9S		H-9D
H-10S		H-10D
H-11S		H-11D
H-12S		H-12D
*H-13S		H-13D
	B-28D	
B-29S		
B-31S		
B-38S		
B-40S	B-40D	
B-43S		
B-43D		
	B-44D	
B-45S	B-45D	
B-48S	B-48D	
B-101S	B-101D	
B-102S		
	B-103D	
B-104S		
B-109S	B-109D	
B-110S	B-110D	
B-122S		
B-124S		
B-125S	B-125D	

* = Monitored for Groundwater Level Only

Table 1b. Monitoring Wells Required Under the Long-Term Groundwater Monitoring Program at the McGraw-Edison Site Albion, Michigan

SUPPLEMENTAL WELLS

(Water Level Measurments Tri-Annually, Water Chemistry by Plan)

	Bedrock Wells	
Shallow Wells	**Interface Wells**	**Deep Wells**
B-30S		No Deep Wells
B-37S		
B-41S		
B-105S		
B-120S		
#B-122S		
*B-28S		
*B-35S	B-35D	
*B-36S		
*B-38S		
*B-39S		
*B-42S	B-42D	
	#B-43D	
*B-47S	B-47D	
*B-118S		
*B-119S		

= Also contained in the Tri-Annual Sampling in Table 1a.

* = Sampled annually under Supplemental Section of Monitoring Plan, the remaining wells are sampled tri-annually .

Table 2. Groundwater Elevations from Shallow Soil Aquifer Wells, March 1992. McGraw-Edison Site Albion, Michigan

(** = Triannual Sampling Site * = Supplemental Sampling Site)

	WELL ID #	REFERENCE ELEVA. (ft MSL)	DATE READ	TIME READ	WATER LEVEL FROM REF. (ft)	WATER TABLE ELEV. (ft MSL)	REMEDIATION REQUIRED AT THE SITE
**	H-1S	984.04	3/23/92	15:15	29.73	954.31	
**	H-2S	983.90	3/23/92	14:38	37.91	945.99	
**	H-3S	985.10					Damaged,bailer stuck in the well below ground {Well should be abandoned and replaced.}
**	H-4S	981.84	3/23/92	10:52	20.69	961.15	
**	H-5S	988.04	3/23/92	9:49	33.68	954.36	Well Wizard packer should be removed.
**	H-6S	967.75	3/23/92	8:55	NM		Well Wizard packer should be removed.
**	H-7S	978.71	3/23/92	11:25	35.84	942.87	{Well needs to be resurveyed.}
**	H-8S	979.95	3/23/92	9:05	22.43	957.52	Well Wizard packer should be removed.
**	H-9S	986.08	3/23/92	9:20	23.61	962.47	Well Wizard packer should be removed.
**	H-10S	969.63	3/25/92			NA	Well Wizard packer should be removed.
**	H-11S	978.46	3/23/92	8:30	28.70	949.76	
**	H-12S	954.91	3/23/92	13:40	DRY	NA	Well historically dry, too shallow. {Well should be abandoned and replaced.}
**	H-13S	968.73	3/23/92	13:48	26.36	942.37	
	B-25S	973.07				NA	Well Abandoned 11/24/87
	B-26S	972.50				NA	Well may have been Abandoned 11/24/87
	B-27S	983.50				NA	Well destroyed during previous construction.
*	B-28S	991.84	3/23/92	10:02	46.63	945.21	
**	B-29S	987.83	3/23/92	9:52	43.96	943.87	Well historically dry, too shallow {Well should be abandoned and replaced.}
*	B-30S	989.71	3/23/92	9:50	DRY	NA	This well is dammaged and maybe silted. {Well should be abandoned and replaced.}
**	B-31S	990.24	3/23/92	9:35	45.01	945.23	
	B-32S	990.47	3/23/92	9:40	32.51	957.96	
*	B-35S	983.54				NA	Well on private property, no access.
*	B-36S	983.54				NA	Well on private property, no access.
*	B-37S	989.96				NA	Well on private property, no access.
*	B-38S	989.25				NA	Well on private property, no access.

Table 2. Groundwater Elevations from Shallow Soil Aquifer Wells, March 1992. McGraw-Edison Site Albion, Michigan

(** = Triannual Sampling Site * = Supplemental Sampling Site)

	WELL ID #	REFERENCE ELEVA. (ft MSL)	DATE READ	TIME READ	WATER LEVEL FROM REF. (ft)	WATER TABLE ELEV. (ft MSL)	REMEDIATION REQUIRED AT THE SITE
**	B-38D	989.07				NA	Well on private property, no access.
*	B-39S	989.43				NA	Well on private property, no access.
**	B-40S	990.07				NA	Well on private property, no access.
*	B-41S	989.06				NA	Well on private property, no access.
*	B-42S	984.57				NA	Well on private property, no access.
**	B-43S	986.61				NA	Well on private property, no access.
**	B-43D	986.47				NA	Well on private property, no access.
**	B-45S	982.85	3/23/92	11:00	28.06	954.79	Top of pro-casing loose. Silty bottom.
						NA	{Install a new protective casing and guards.}
	B-46S	982.81	3/23/92	11:36	31.18	951.63	
*	B-47S	984.04	3/23/92	11:39	32.15	951.89	
**	B-48S	982.16	3/23/92	11:32	DRY	NA	Well too shallow, usually reported dry. {Substitute using B-46s or reinstall.}
**	B-101S	983.51	3/23/92	10:34	25.64	957.87	Pro-casing loose. Surface Water may enter. {Install a new protective casing and guards.}
**	B-102S	X	3/23/92	14:16		NA	Pro-casing and PVC broken off well covered. {Abandon and reinstall a new well.}
	B-102D	979.81	3/23/92	14:16	35.38	944.43	
	B-103S	986.46	3/23/92	10:05	DRY	NA	
**	B-104S	982.46	3/24/92	11:48	28.22	954.24	
*	B-105S					NA	Wells destroyed during previous construction. {Install a new well at this site.}
	B-106S					NA	Wells destroyed during previous construction.
	B-107S					NA	Wells destroyed during previous construction.
	B-108S					NA	Wells destroyed during previous construction.
**	B-109S	979.94	3/23/92	11:05	28.28	951.66	
**	B-110S	983.84	3/23/92	15:26	28.16	955.68	Well casing is bent. {Remove & reinstall a new protective casing.}
	B-111S	982.25	3/23/92	15:33	25.76	956.49	

Table 2. Groundwater Elevations from Shallow Soil Aquifer Wells, March 1992.
McGraw-Edison Site Albion, Michigan

(** = Triannual Sampling Site * = Supplemental Sampling Site)

	WELL ID #	REFERENCE ELEVA. (ft MSL)	DATE READ	TIME READ	WATER LEVEL FROM REF. (ft)	WATER TABLE ELEV. (ft MSL)	REMEDIATION REQUIRED AT THE SITE
	B-112S	980.52	3/23/92	15:35	25.55	954.97	
	B-113S	980.48	3/23/92	10:21	19.61	960.87	
	B-114S	989.53	3/23/92	13:48	36.26	953.27	
	B-115S	979.81	3/23/92	14:22	21.32	958.49	
	B-116S					NA	Wells destroyed during previous construction.
	B-117S	987.45	3/23/92	11:03	44.48	942.97	
*	B-118S	981.73	3/23/92	14:28	39.10	942.63	
*	B-119S	981.80	3/23/92	14:42	37.62	944.18	
*	B-120S	981.80	3/23/92	14:32	38.35	943.45	
**	B-122S	980.66	3/23/92	14:19	38.49	942.17	
	B-123S	981.80	3/23/92	14:46	32.78	949.02	
**	B-124S	989.78	3/23/92	11:19	45.00	944.78	
**	B-125S					NA	New well installation stipulated by MDNR. {Install a new well at this location.}
	B-126S	?				NA	? Well 126-SP near plant.

All of the above monitoring wells should be re-surveyed and tied into the August 1991 survey datum.

tbl2392.xls

Table 3. Groundwater Elevations from Wells Completed in Bedrock or at the Bedrock/Soil Interface, March 1992. McGraw-Edison Site in Albion, Michigan

(** = Triannual Sampling Site * = Supplemental Sampling Site)

	WELL ID #	REFERENCE ELEVA. (ft MSL)	DATE READ	TIME READ	WATER LEVEL FROM REF. (ft)	WATER TABLE ELEV. (ft MSL)	REMEDIATION REQUIRED AT THE SITE
**	H-1D	983.69	3/23/92	15:15	42.51	941.18	{Repair and reinstall Well-Wizzard.}
**	H-2D	982.71	3/23/92	14:38	40.86	941.85	
**	H-3D	980.90				NA	Well destroyed during construction. {Install a new well.}
**	H-4D	980.72	3/23/92	10:52	38.32	942.40	
**	H-5D	987.69	3/23/92	9:49	44.52	943.17	{Repair and reinstall Well-Wizzard.}
**	H-6D	964.76	3/23/92	8:55	21.24	943.52	
**	H-7D	979.22	3/23/92	11:25	37.80	941.42	{Well elevation needs resurveyed.}
**	H-8D	979.61	3/23/92	9:05	38.70	940.91	
**	H-9D	985.55	3/23/92	9:20	44.24	941.31	
**	H-10D	969.96	3/25/92	11:00	28.26	941.70	
**	H-11D	977.97	3/23/92	8:30	34.43	943.54	{Repair and reinstall Well-Wizzard.}
**	H-12D	954.30	3/23/92	13:40	11.26	943.04	Well needs a locking well cap to secure. {A new flush mount protective cover needed.} {Repair and reinstall Well-Wizzard.}
**	H-13D	965.59	3/23/92	13:48	24.44	941.15	
	B-25D	973.28				NA	Well Abandoned 11/24/87
**	B-28D	991.63	3/23/92	10:02	46.58	945.05	
	B-32D	990.47	3/23/92	9:40	44.04	946.43	
*	B-35D	986.69				NA	Well on private property, no access.
	B-38D	989.07				NA	Well on private property, no access.
**	B-40D	990.08				NA	Well on private property, no access.
*	B-42D	984.61				NA	Well on private property, no access.
*	B-43D	986.47				NA	Well on private property, no access.
**	B-44D	988.07				NA	Well on private property, no access.
**	B-45D	982.95	3/23/92	11:00	39.86	943.09	{Install well guard posts.}
	B-46D	982.83	3/23/92	11:36	34.40	948.43	
*	B-47D	983.73	3/23/92	11:39	40.54	943.19	
**	B-48D	982.08	3/23/92	11:32	38.80	943.28	

Table 3. Groundwater Elevations from Wells Completed in Bedrock or at the Bedrock/Soil Interface, March 1992. McGraw-Edison Site in Albion, Michigan

(** = Triannual Sampling Site * = Supplemental Sampling Site)

	WELL ID #	REFERENCE ELEVA. (ft MSL)	DATE READ	TIME READ	WATER LEVEL FROM REF. (ft)	WATER TABLE ELEV. (ft MSL)	REMEDIATION REQUIRED AT THE SITE
**	B-101D	983.50	3/23/92	10:34	37.51	945.99	Pro-casing Loose. Surface water may enter. {Extend well and install new pro-casing}
**	B-103D	986.85	3/23/92	10:06	43.90	942.95	
	B-104D	983.18	3/23/92	11:48		NA	BROKEN-OFF Below Ground Surface (B.G.S.) {Abandon well to minimize contamination.}
	B-105D					NA	Well destroyed during previous construction.
	B-106D	980.18	3/23/92	14:22	36.74	943.44	
	B-107D					NA	Well destroyed during previous construction.
	B-108D					NA	Well destroyed during previous construction.
**	B-109D	979.69	3/23/92	11:05	37.51	942.18	
**	B-110D	983.70	3/23/92	15:27	43.24	940.46	{Install well guard posts.}
	B-111D	982.22	3/23/92	15:32	39.31	942.91	{Resurvey the top of casing.}
	B-112D	980.81	3/23/92	15:34	39.65	941.16	{Resurvey the top of casing.}
	B-113D	980.80	3/23/92	10:21	25.35	955.45	
	B-121D	984.68				NA	Small lock for locking cap missing. {Resurvey the top of casing.}
**	B-125D	983.09	3/23/92	10:40	41.70	941.39	Dammaged well casing can't be sampled. {Install a new well and guard posts.}

All of the above wells should be re-surveyed and tied into the August 1992 survey datum.

Table 4. Groundwater Elevations from Wells Along the Recovery System, March 1992. McGraw-Edison Site Albion, Michigan

WELL ID #	REFERENCE ELEVA. (ft MSL)	DATE READ	TIME READ	WATER LEVEL FROM REF. (ft)	WATER TABLE ELEV. (ft MSL)	REMARKS OR REMEDIATION NEEDED
1A	977.31				NA	Recovery well . No measurement made.
P-1	983.83	3/23/92	8:34	29.36	954.47	Shallow soil aquifer piezometer.
2A	977.25				NA	Recovery well . No measurement made.
P-2	983.86	3/23/92	8:58	29.23	954.63	Shallow soil aquifer piezometer.
3A	976.27				NA	Recovery well . No measurement made.
P-3B	984.30	3/23/92	9:11	40.97	943.33	Deep soil aquifer piezometer.
P-3	984.27	3/23/92	9:10	29.84	954.43	Shallow soil aquifer piezometer.
4A	976.65				NA	Recovery well . No measurement made.
P-4	984.18	3/23/92	9:14	29.98	954.20	Shallow soil aquifer piezometer.
5A	975.93				NA	Recovery well . No measurement made.
P-5	984.22	3/23/92	9:17	30.31	953.91	Shallow soil aquifer piezometer.
6A	976.20				NA	Recovery well . No measurement made.
P-6	984.26	3/23/92	9:22	30.71	953.55	Shallow soil aquifer piezometer.
7A	976.82				NA	Recovery well . No measurement made.
P-7B	984.75	3/23/92	9:26	42.57	942.18	Shallow soil aquifer piezometer.
P-7	984.27	3/23/92	9:25	31.20	953.07	Deep soil aquifer piezometer.
8A	976.16				NA	Recovery well . No measurement made.
P-8	984.43	3/23/92	9:31	DRY	NA	Shallow soil aquifer piezometer.
9B					NA	Installed in well pit. Needs resurveyed
P-9	984.53	3/23/92	9:34	39.30	945.23	Shallow soil aquifer piezometer.
10A	977.01				NA	Recovery well . No measurement made.
P-10	984.99	3/23/92	9:40	41.83	943.16	Shallow soil aquifer piezometer.
11B					NA	Installed in well pit. Needs resurveyed
B-103D	986.85	3/23/92	10:06	43.90	942.95	Needs resurveyed to 1991 elvation datum(estimated)
B-103S	986.46	3/23/92	10:05	DRY	NA	Needs resurveyed to 1991 elvation datum(estimated)
P-11	987.77	3/23/92	10:08	44.80	942.97	Shallow soil aquifer piezometer.
12A	985.78				NA	Recovery well . No measurement made.
P-12	987.72	3/23/92	10:15	45.24	942.48	Shallow soil aquifer piezometer.
W-1	980.47				NA	Recovery well . No measurement made.

tbl4392.xls

Table 4. Groundwater Elevations from Wells Along the Recovery System, March 1992.
McGraw-Edison Site Albion, Michigan

WELL ID #	REFERENCE ELEVA. (ft MSL)	DATE READ	TIME READ	WATER LEVEL FROM REF. (ft)	WATER TABLE ELEV. (ft MSL)	REMARKS OR REMEDIATION NEEDED
P-13	987.42	3/23/92	10:18	45.20	942.22	Shallow soil aquifer piezometer.
13A	979.60				NA	Recovery well . No measurement made.
P-14	987.43	3/23/92	10:22	45.35	942.08	Shallow soil aquifer piezometer.
W-2	980.96				NA	Recovery well . No measurement made.
P-15	987.15	3/23/92	10:26	45.40	941.75	Shallow soil aquifer piezometer.
14A	980.19				NA	Recovery well . No measurement made.
P-16	987.94	3/23/92	10:40	46.45	941.49	Shallow soil aquifer piezometer.
P-16B	988.67	3/23/92	10:41	47.17	941.50	Deep soil aquifer piezometer.
W-3	981.35				NA	Recovery well . No measurement made.
P-17	988.68	3/23/92	10:51	46.72	941.96	Shallow soil aquifer piezometer.
15A	980.13				NA	Recovery well . No measurement made.
P-18	988.79	3/23/92	10:34	46.49	942.30	Shallow soil aquifer piezometer.
W-4	980.91				NA	Recovery well . No measurement made.
P-19B	987.31	3/23/92	10:59	45.21	942.10	Deep soil aquifer piezometer.
P-19	987.57	3/23/92	10:58	45.04	942.53	Shallow soil aquifer piezometer.
16A	980.03				NA	Recovery well . No measurement made.
B-117S	987.45	3/23/92	11:03	44.48	942.97	Needs resurveyed to 1991 elvation datum(estimated)
P-20	987.74	3/23/92	11:06	44.60	943.14	Shallow soil aquifer piezometer.
W-5	981.13				NA	Recovery well . No measurement made.
P-21B	988.62	3/23/92	11:13	45.40	943.22	Deep soil aquifer piezometer.
P-21	988.74	3/23/92	11:12	45.50	943.24	Shallow soil aquifer piezometer.
17A					NA	Installed in well pit. Needs resurveyed
P-22	990.10	3/23/92	11:17	46.49	943.61	Shallow soil aquifer piezometer.
W-6	982.73				NA	Recovery well . No measurement made.
B-124S	989.78	3/23/92	11:19	45.00	944.78	Needs resurveyed to 1991 elvation datum(estimated)
P-23	990.11	3/23/92	11:28	46.22	943.89	Shallow soil aquifer piezometer.
18A	982.16				NA	Recovery well . No measurement made.
P-24B	991.18	3/23/92	11:35	46.40	944.78	Deep soil aquifer piezometer.
P-24	990.46	3/23/92	11:34	45.64	944.82	Shallow soil aquifer piezometer.

tbl4392.xls

Table 4. Groundwater Elevations from Wells Along the Recovery System, March 1992. McGraw-Edison Site Albion, Michigan

WELL ID #	REFERENCE ELEVA. (ft MSL)	DATE READ	TIME READ	WATER LEVEL FROM REF. (ft)	WATER TABLE ELEV. (ft MSL)	REMARKS OR REMEDIATION NEEDED
19A	982.33				NA	Recovery well . No measurement made.
P-25	991.14	3/23/92	11:40	45.86	945.28	Shallow soil aquifer piezometer.
20A	982.64				NA	Recovery well . No measurement made.
P-26	990.49	3/23/92	11:43	44.19	946.30	Shallow soil aquifer piezometer.
W-8	983.21				NA	Recovery well . No measurement made.
P-27B	990.12	3/23/92	11:48	43.07	947.05	Deep soil aquifer piezometer.
P-27	990.77	3/23/92	11:47	43.70	947.07	Shallow soil aquifer piezometer.
21A	981.94				NA	Recovery well . No measurement made.
P-28	989.41	3/23/92	13:34	41.45	947.96	Shallow soil aquifer piezometer.
W-9	982.60				NA	Recovery well . No measurement made.
P-29	989.04	3/23/92	13:40	DRY	NA	Shallow soil aquifer piezometer.
22A	981.52				NA	Recovery well . No measurement made.
23B					NA	Installed in well pit. Needs resurveyed
P-30B	988.32	3/23/92	13:43	38.16	950.16	Deep soil aquifer piezometer.
P-30	988.63	3/23/92	13:42	38.52	950.11	Shallow soil aquifer piezometer.
23A					NA	No longer a recovery well. Resurvey needed.
B-114S	989.53	3/23/92	13:48	36.26	953.27	Needs resurveyed to 1991 elvation datum(estimated)
P-31	987.83	3/23/92	13:50	39.88	947.95	Shallow soil aquifer piezometer.
24A	980.25				NA	Recovery well . No measurement made.
P-32	985.96	3/23/92	13:56	DRY	NA	Shallow soil aquifer piezometer.
25A	978.27				NA	Recovery well . No measurement made.
P-33B	985.20	3/23/92	13:59	27.26	957.94	Deep soil aquifer piezometer.
P-33	984.97	3/23/92	13:58	26.98	957.99	Shallow soil aquifer piezometer.
26A	977.11				NA	Recovery well . No measurement made.
P-34	983.96	3/23/92	14:04	26.00	957.96	Shallow soil aquifer piezometer.
27A	976.75				NA	Recovery well . No measurement made.
B-101S	983.51	3/23/92	10:34	25.64	957.87	Needs resurveyed to 1991 elvation datum(estimated)
B-101D	983.51	3/23/92	10:35	37.51	946.00	Needs resurveyed to 1991 elvation datum(estimated)

tbl4392.xls

TABLE 5
SUMMARY OF TRICHLOROETHYLENE MEASUREMENTS FOR THE SHALLOW AQUIFER, 1984 TO MARCH 1992

MONITORING WELL	1984 ug/l	1986 ug/l	1988 ug/l	June 1990 ug/l	July 1991 ug/l	March 1992 ug/l
H-1s	-	90	38	64	38	51
H-2s	-	1000	180	160	ND	150
H-3s	-	76000	3900	-	-	-
H-4s	-	11	20	28	7.7	7.5
H-5s	-	63	25	27	33	110
H-5s Duplicate	-	-	-	-	-	84
H-6s	-	1	ND	ND	ND	14
H-7s	-	7	5	2.9	9.7	23
H-8s	-	1	ND	ND	ND	ND
H-9s	-	1	ND	ND	ND	ND
H-10s	-	ND	ND	ND	ND	ND
H-11s	-	3	2	ND	1.2	1.9
H-12s	-	-	-	ND	-	-
H-13s	-	-	-	ND	ND	ND
B-28s	-	-	-	110	280	66
B-29s	3600	-	320	120	63	130
B-31s	1700	-	780	530	440	270
B-32s	56	-	10	-	-	54
B-35s	ND	-	ND	-	-	-
B-36s	5.5	-	3	-	-	-
B-38s	1.4	-	ND	-	-	-
B-38d	85	-	4800	-	-	-
B-40s	1.2	-	2	-	-	-
B-42s	18.4	-	6	-	-	-
B-42d	16.8	-	8	-	-	-
B-43s	ND	-	14	-	-	-
B-45s	48	-	190	81	18	38
B-46s	-	-	-	-	15	5.6
B-47s	14.5	-	15	11	ND	ND

TABLE 5
SUMMARY OF TRICHLOROETHYLENE MEASUREMENTS FOR THE SHALLOW AQUIFER, 1984 TO MARCH 1992

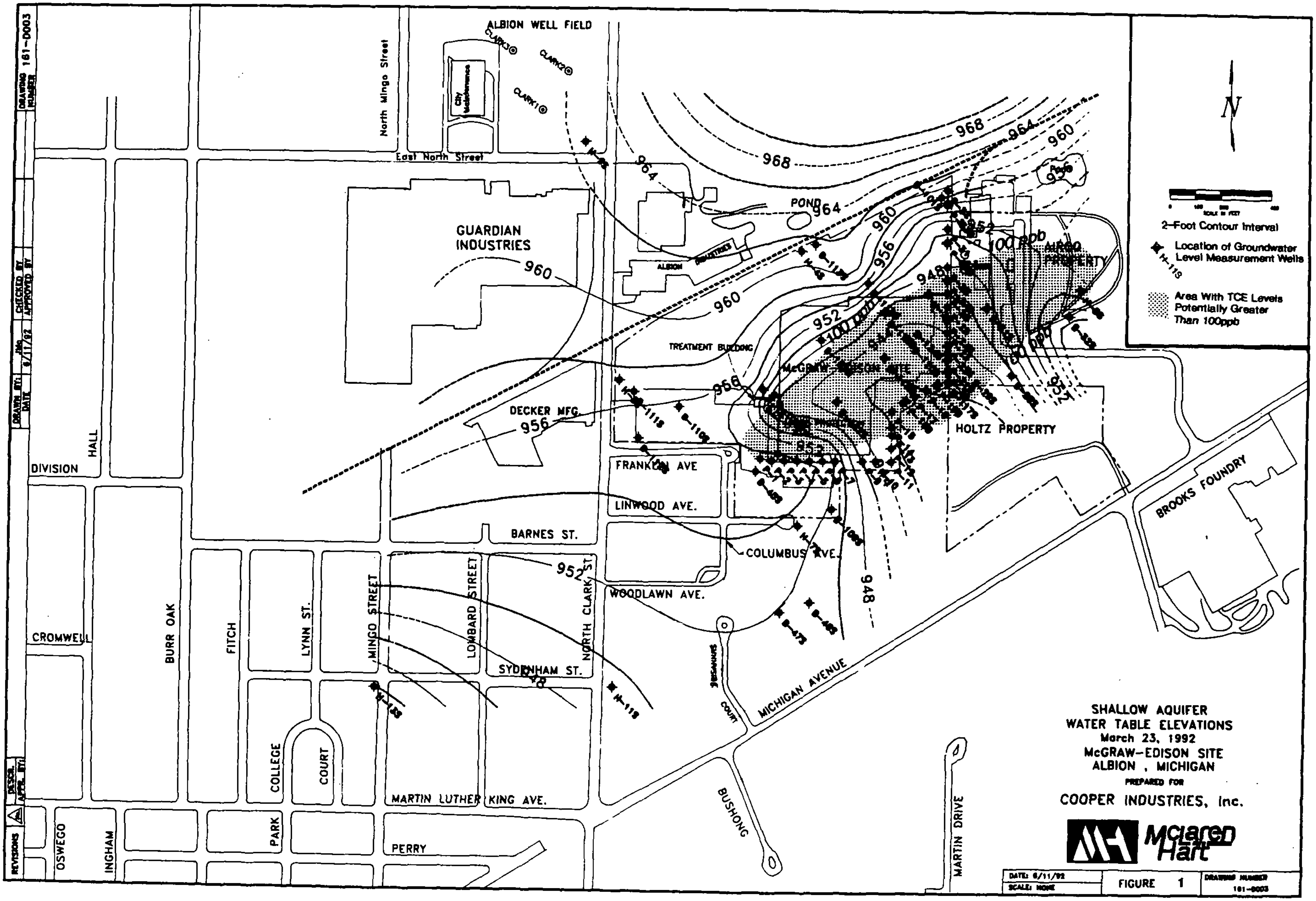
MONITORING WELL	1984 ug/l	1986 ug/l	1988 ug/l	June 1990 ug/l	July 1991 ug/l	March 1992 ug/l
B-101s	-	-	-	28	27	27
B-102s	47	-	8	-	-	-
B-104s	71	-	210	230	200	190
B-109s	3.4	-	2	0.86	ND	ND
B-110s	-	-	-	-	10	33
B-112s	1.8	-	1	-	-	-
B-115s	-	-	-	-	110	2.1
B-117s	19500	-	540	-	-	-
B-118s	-	-	-	1500	-	-
B-119s	-	-	-	140	-	-
B-120s	-	-	-	1900	-	-
B-122s	8.6	-	420	500	380	170
B-124s	522	-	1500	2800	1500	2200
P-3	-	-	-	-	-	91
P-3B	-	-	-	-	-	130
P-11	-	-	-	-	-	14
P-16	-	-	-	-	400	500
P-16B	-	-	-	-	41	620
P-19	-	-	-	-	-	250
P-19B	-	-	-	-	-	2.1
Trip Blanks						
TB-1	-	-	-	-	-	ND
TB#2	-	-	-	-	-	ND

ND = Below the detection limit of 1.0 ppb.
" - " = Not sampled on this date.

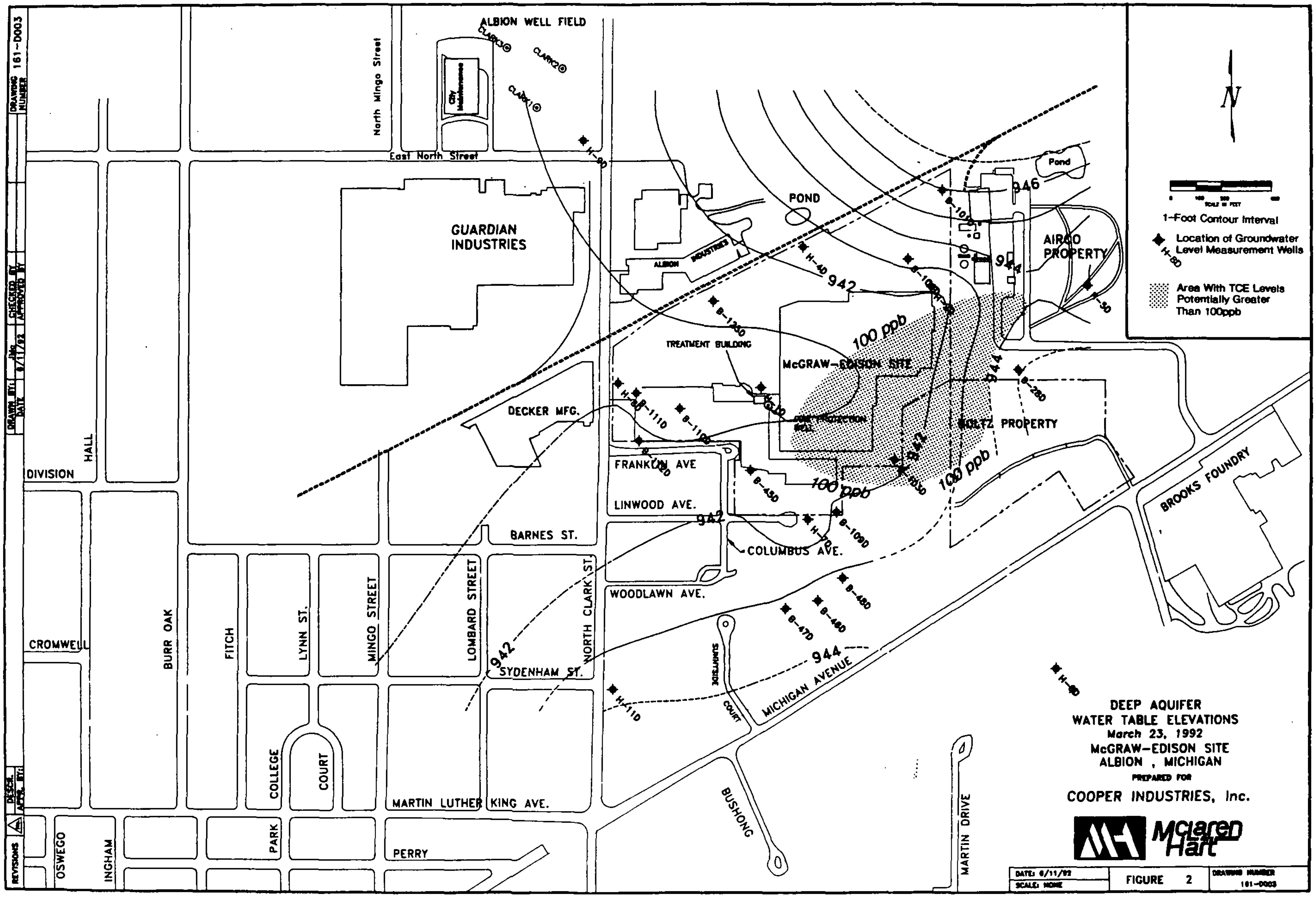
TABLE 6
SUMMARY OF TRICHLOROETHYLENE MEASUREMENTS FOR THE DEEP AQUIFER, 1984 TO MARCH 1992

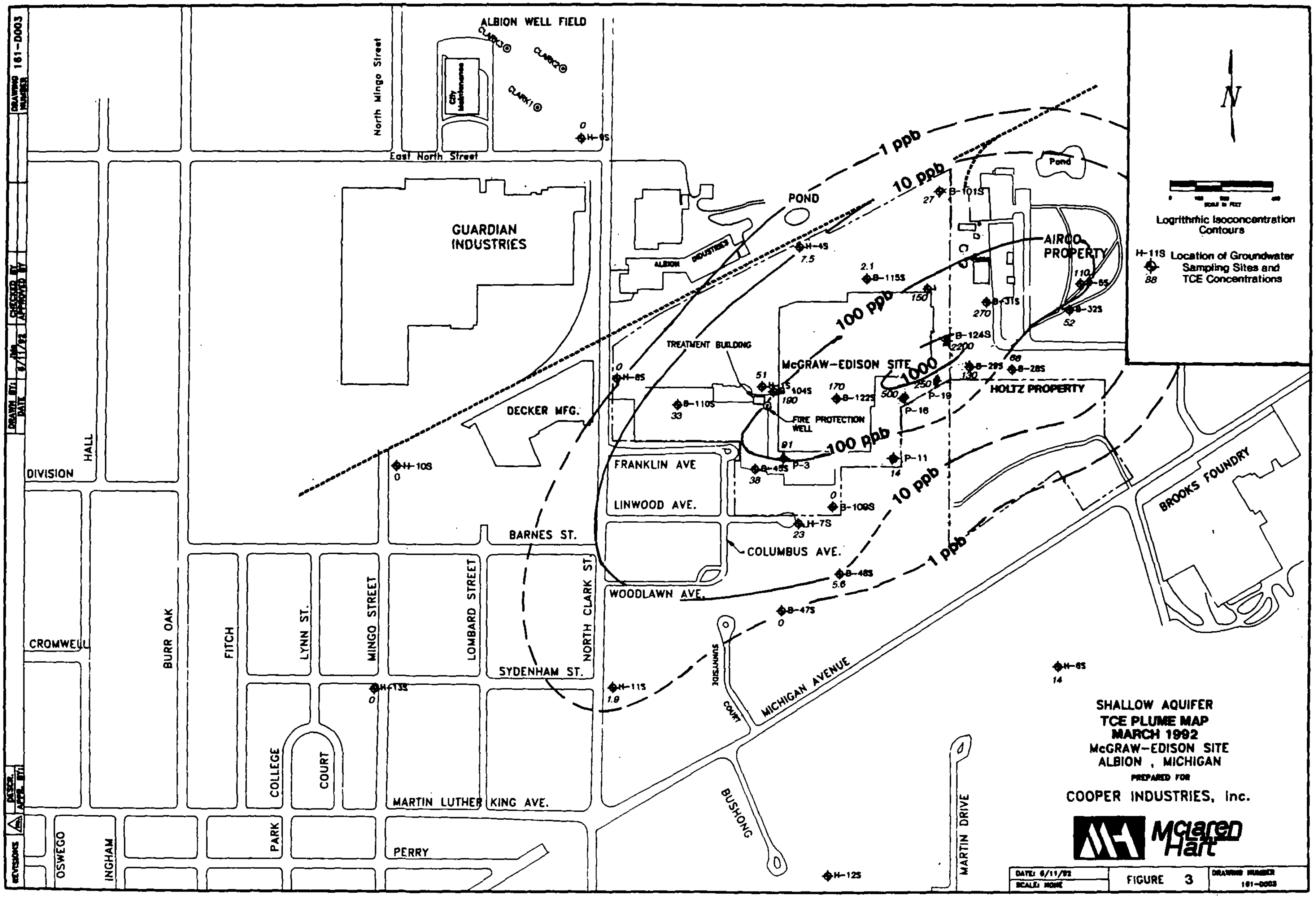
MONITORING WELL	1984	1986	1988	June 1990	July 1991	March 1992
	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
H-1d	-	6	5	2.4	ND	1.5
H-2d	-	76	33	17	49	56
H-3d	-	ND	ND	-	-	-
H-4d	-	1	1	0.84	ND	ND
H-5d	-	ND	ND	ND	ND	ND
H-6d	-	ND	ND	3	8.9	ND
H-7d	-	1	ND	0.22	ND	ND
H-8d	-	7	1	0.94	ND	ND
H-8d Duplicate	-	-	-	-	-	ND
H-9d	-	1	ND	ND	ND	ND
H-10d	-	4	ND	0.21	ND	3.5
H-11d	-	ND	1	ND	ND	ND
H-12d	-	ND	ND	ND	ND	ND
H-13d	-	ND	ND	ND	ND	ND
B-28d	3.7	-	6	16	20	29
B-32d	-	-	-	-	-	88
B-40d	355	-	36	-	-	-
B-43d	ND	-	10	-	-	-
B-44d	23	-	9	-	-	-
B-45d	253	-	190	280	33	44
B-47d	3.2	-	3	0.34	ND	1.7
B-48d	ND	-	2	0.6	-	-
B-101d	-	-	-	ND	ND	ND
B-102d	-	-	-	-	-	
B-103d	513	-	154	690	210	240
B-106d	-	-	-	-	-	38
B-109d	186	-	20	19	5	ND
B-110d	1.5	-	1	0.8	ND	1.4
B-112d	4.5	-	4	-	-	-
B-125d	855	-	400	-	-	-

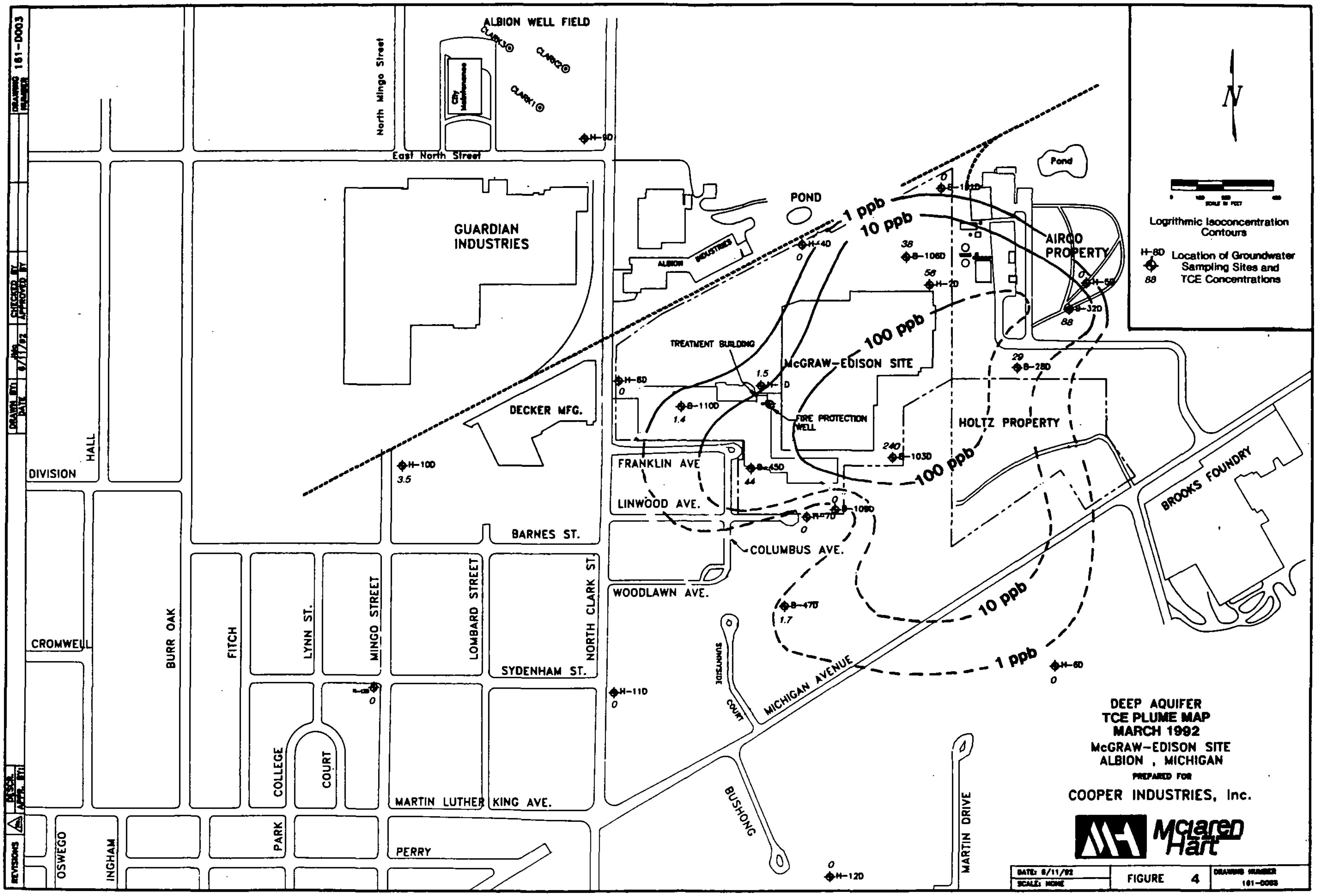
ND = Below the detection limit of 1.0 ppb.
" - " = Not sampled on this date.



ALBION WELL FIELD
CLARK3
CLARK2
CLARK1
City Maintenance
North Mingo Street
East North Street
GUARDIAN INDUSTRIES
POND
ALBION
TREATMENT BUILDING
McGRAW-EDISON SITE
AIRCO PROPERTY
HOLTZ PROPERTY
DECKER MFG.
BROOKS FOUNDRY
968
964
960
956
952
948
100 ppb
2-Foot Contour Interval
Location of Groundwater Level Measurement Wells
Area With TCE Levels Potentially Greater Than 100ppb
N
DIVISION
HALL
CROMWELL
BURR OAK
FITCH
LYNN ST.
MINGO STREET
LOMBARD STREET
NORTH CLARK ST.
SYDENHAM ST.
FRANKLIN AVE
LINWOOD AVE.
BARNES ST.
COLUMBUS AVE.
WOODLAWN AVE.
MICHIGAN AVENUE
COURT
COLLEGE
MARTIN LUTHER KING AVE.
PARK
PERRY
OSWEGO
INGHAM
BUSHONG
MARTIN DRIVE
REVISIONS
DRAWING NUMBER 161-0003
SHALLOW AQUIFER
WATER TABLE ELEVATIONS
March 23, 1992
McGRAW-EDISON SITE
ALBION, MICHIGAN
PREPARED FOR
COOPER INDUSTRIES, Inc.
McLaren Hart
DATE: 6/11/92
SCALE: NONE
FIGURE 1
161-0003


ALBION WELL FIELD
CLARK3
CLARK2
CLARK1
City Maintenance
North Mingo Street
East North Street
GUARDIAN INDUSTRIES
ALBION INDUSTRIES
POND
Pond
946
944
942
AIRCO PROPERTY
TREATMENT BUILDING
McGRAW-EDISON SITE
100 ppb
DECKER MFG.
BOLTZ PROPERTY
BROOKS FOUNDRY
FRANKLIN AVE
LINWOOD AVE.
BARNES ST.
COLUMBUS AVE.
WOODLAWN AVE.
DIVISION
HALL
CROMWELL
BURR OAK
FITCH
LYNN ST.
MINGO STREET
LOMBARD STREET
NORTH CLARK ST.
SYDENHAM ST.
MICHIGAN AVENUE
SUNNYSIDE COURT
COLLEGE
COURT
PARK
MARTIN LUTHER KING AVE.
PERRY
OSWEGO
INGHAM
BUSHONG
MARTIN DRIVE
H-90
H-40
H-50
H-60
H-70
H-80
H-110
B-1010
B-1050
B-1250
B-1110
B-1100
B-450
B-1090
B-1030
B-280
B-470
B-460
B-480
N
1-Foot Contour Interval
Location of Groundwater Level Measurement Wells
Area With TCE Levels Potentially Greater Than 100ppb
DEEP AQUIFER
WATER TABLE ELEVATIONS
March 23, 1992
McGRAW-EDISON SITE
ALBION, MICHIGAN
PREPARED FOR
COOPER INDUSTRIES, Inc.
McLaren Hart
DATE: 6/11/92
SCALE: NONE
FIGURE 2
DRAWING NUMBER 161-0003
DRAWING NUMBER 161-D003
DRAWN BY
DATE
CHECKED BY
APPROVED BY
REVISIONS


ALBION WELL FIELD
GUARDIAN INDUSTRIES
DECKER MFG.
TREATMENT BUILDING
McGRAW-EDISON SITE
FIRE PROTECTION WELL
AIRCO PROPERTY
HOLTZ PROPERTY
BROOKS FOUNDRY
POND
Pond
1 ppb
10 ppb
100 ppb
1000
East North Street
North Mingo Street
DIVISION
HALL
CROMWELL
BURR OAK
FITCH
LYNN ST.
MINGO STREET
LOMBARD STREET
NORTH CLARK ST.
FRANKLIN AVE
LINWOOD AVE.
BARNES ST.
COLUMBUS AVE.
WOODLAWN AVE.
SYDENHAM ST.
SUNNYSIDE COURT
MICHIGAN AVENUE
COLLEGE
COURT
MARTIN LUTHER KING AVE.
PARK
PERRY
OSWEGO
INGHAM
BUSHONG
MARTIN DRIVE
N
Logrithmic Isoconcentration Contours
H-11S Location of Groundwater Sampling Sites and TCE Concentrations
88
SHALLOW AQUIFER
TCE PLUME MAP
MARCH 1992
McGRAW-EDISON SITE
ALBION , MICHIGAN
PREPARED FOR
COOPER INDUSTRIES, Inc.
McLaren Hart
FIGURE 3
DRAWING NUMBER 161-0003


DEEP AQUIFER
TCE PLUME MAP
MARCH 1992
McGRAW-EDISON SITE
ALBION , MICHIGAN
PREPARED FOR
COOPER INDUSTRIES, Inc.
McLaren Hart
FIGURE 4
DRAWING NUMBER 161-D003
Logrithmic Isoconcentration Contours
Location of Groundwater Sampling Sites and TCE Concentrations
N
ALBION WELL FIELD
GUARDIAN INDUSTRIES
DECKER MFG.
McGRAW-EDISON SITE
TREATMENT BUILDING
FIRE PROTECTION WELL
AIRCO PROPERTY
HOLTZ PROPERTY
BROOKS FOUNDRY
POND
Pond
1 ppb
10 ppb
100 ppb
East North Street
North Mingo Street
DIVISION
HALL
CROMWELL
BURR OAK
FITCH
LYNN ST.
MINGO STREET
LOMBARD STREET
NORTH CLARK ST.
BARNES ST.
SYDENHAM ST.
FRANKLIN AVE
LINWOOD AVE.
COLUMBUS AVE.
WOODLAWN AVE.
MICHIGAN AVENUE
SUNNYSIDE COURT
BUSHONG
MARTIN DRIVE
MARTIN LUTHER KING AVE.
COLLEGE
COURT
PARK
PERRY
OSWEGO
INGHAM
H-100
3.5
H-11D
H-12D
H-6D
H-4D
B-110D
1.4
B-45D
44
H-7D
B-109D
B-47D
1.7
B-103D
240
B-28D
29
B-32D
88
B-106D
38
H-2D
56
H-5D

SAVANNAH LABORATORIES
& ENVIRONMENTAL SERVICES, INC.

5102 LaRoche Avenue • Savannah, GA 31404 • (912) 354-7858 • Fax (912) 352-0165

RECEIVED
APR 24 1992
McLAREN/HART

LOG NO: S2-41373

Received: 25 MAR 92

Mr. Roy Cox
McLaren Hart
29225 Chagrin Blvd.
Cleveland, OH 44122

Project: 08.0000103.004/Albion
Sampled By: Client

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , LIQUID SAMPLES	DATE SAMPLED
41373-1	B-28S	03-24-92
41373-2	B-28D	03-24-92
41373-3	B-29S	03-24-92
41373-4	B-31S	03-24-92
41373-5	H4D	03-24-92

PARAMETER	41373-1	41373-2	41373-3	41373-4	41373-5
Purgeable Halocarbons (601)					
Trichloroethene, ug/l	66	29	130	270	<1.0
Surrogate - Bromochloromethane % Rec	110	102	95	91	104

SL SAVANNAH LABORATORIES
& ENVIRONMENTAL SERVICES, INC.

5102 LaRoche Avenue • Savannah, GA 31404 • (912) 354-7858 • Fax (912) 352-0165

LOG NO: S2-41373

Received: 25 MAR 92

Mr. Roy Cox
McLaren Hart
29225 Chagrin Blvd.
Cleveland, OH 44122

Project: 08.0000103.004/Albion
Sampled By: Client

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , LIQUID SAMPLES	DATE SAMPLED
41373-6	B-45S	03-23-92
41373-7	B-45D	03-24-92
41373-8	B-46S	03-23-92
41373-9	B-47D	03-23-92
41373-10	B-102D	03-24-92

PARAMETER	41373-6	41373-7	41373-8	41373-9	41373-10
Purgeable Halocarbons (601)					
Trichloroethene, ug/l	38	44	5.6	1.7	23
Surrogate - Bromochloromethane % Rec	93	94	81	94	91

SL SAVANNAH LABORATORIES
& ENVIRONMENTAL SERVICES, INC.

5102 LaRoche Avenue • Savannah, GA 31404 • (912) 354-7858 • Fax (912) 352-0165

LOG NO: S2-41373

Received: 25 MAR 92

Mr. Roy Cox
McLaren Hart
29225 Chagrin Blvd.
Cleveland, OH 44122

Project: 08.0000103.004/Albion
Sampled By: Client

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , LIQUID SAMPLES	DATE SAMPLED
41373-11	B-106D	03-24-92
41373-12	B-109D	03-23-92
41373-13	B-109S	03-24-92
41373-14	B-104S	03-24-92
41373-15	B-110D	03-24-92

PARAMETER	41373-11	41373-12	41373-13	41373-14	41373-15
Purgeable Halocarbons (601)					
Trichloroethene, ug/l	38	<1.0	<1.0	190	1.4
Surrogate - Bromochloromethane % Rec	86	54	85	80	94

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Received: 25 MAR 92

Mr. Roy Cox
McLaren Hart
29225 Chagrin Blvd.
Cleveland, OH 44122

Project: 08.0000103.004/Albion
Sampled By: Client

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , LIQUID SAMPLES	DATE SAMPLED
41373-16	B-110S	03-24-92
41373-17	B-115	03-24-92
41373-18	H-1D	03-24-92
41373-19	H-2D	03-24-92
41373-20	H-2S	03-24-92

PARAMETER	41373-16	41373-17	41373-18	41373-19	41373-20
Purgeable Halocarbons (601)					
Trichloroethene, ug/l	33	2.1	1.5	56	150
Surrogate - Bromochloromethane % Rec	96	100	89	97	115

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Received: 25 MAR 92

Mr. Roy Cox
McLaren Hart
29225 Chagrin Blvd.
Cleveland, OH 44122

Project: 08.0000103.004/Albion
Sampled By: Client

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , LIQUID SAMPLES	DATE SAMPLED
41373-21	H-4S	03-24-92
41373-22	H-6D	03-24-92
41373-23	H-6S	03-24-92
41373-24	H-8D	03-24-92
41373-25	H-8S	03-24-92

PARAMETER	41373-21	41373-22	41373-23	41373-24	41373-25
Purgeable Halocarbons (601)					
Trichloroethene, ug/l	7.5	<1.0	14	<1.0	<1.0
Surrogate - Bromochloromethane % Rec	94	94	88	87	92

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LOG NO: S2-41373

Received: 25 MAR 92

Mr. Roy Cox
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Cleveland, OH 44122

Project: 08.0000103.004/Albion
Sampled By: Client

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , LIQUID SAMPLES	DATE SAMPLED
41373-26	H-9S	03-24-92
41373-27	H-9D	03-24-92
41373-28	H-13D	03-24-92
41373-29	H-13S	03-24-92
41373-30	H-14S Blind Replicate of H-8D	03-24-92

PARAMETER	41373-26	41373-27	41373-28	41373-29	41373-30
Purgeable Halocarbons (601)					
Trichloroethene, ug/l	<1.0	<1.0	<1.0	<1.0	<1.0
Surrogate - Bromochloromethane % Rec	90	83	85	85	90

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& ENVIRONMENTAL SERVICES, INC.

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LOG NO: S2-41373

Received: 25 MAR 92

Mr. Roy Cox
McLaren Hart
29225 Chagrin Blvd.
Cleveland, OH 44122

Project: 08.0000103.004/Albion
Sampled By: Client

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , LIQUID SAMPLES	DATE SAMPLED
41373-31	~~H-15~~ H-15	03-24-92
41373-32	Trip Blank #2	03-24-92

PARAMETER	41373-31	41373-32
Purgeable Halocarbons (601)		
Trichloroethene, ug/l	51	<1.0
Surrogate - Bromochloromethane % Rec	91	115

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& ENVIRONMENTAL SERVICES, INC.

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LOG NO: S2-41373

Received: 25 MAR 92

Mr. Roy Cox
McLaren Hart
29225 Chagrin Blvd.
Cleveland, OH 44122

Project: 08.0000103.004/Albion
Sampled By: Client

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR LIQUID SAMPLES
41373-33	Method Blank-Water
41373-34	Accuracy (Mean % Recovery)-Water
41373-35	Precision (% RPD)-Water
41373-36	Date Analyzed-Water

PARAMETER	41373-33	41373-34	41373-35	41373-36
Purgeable Halocarbons (601)				
Trichloroethene, ug/l	<1.0	140 %	3.6 %	04.01-3.92

Methods: EPA 40 CFR Part 136

Steven J. White

Steven J. White

FEDERAL EXPRESS

[redacted]

QUESTIONS? CALL 800-238-5355 TOLL FREE. 41373

AIRBILL
PACKAGE TRACKING NUMBER

2162603402

55 2162603402

RECIPIENT'S COPY

1 [redacted] Date 3/24/92

From (Your Name) Please Print: ROY COX
Your Phone Number (Very Important): (216) 464 6564
Company: [illegible]
Department/Floor No
Street Address: [illegible] CHAGRIN [illegible] FL
City: [illegible]
State: [illegible]
ZIP Required: 4 4 1 [illegible] 2

2 To (Recipient's Name) Please Print: SAVANNAH LABS
Recipient's Phone Number (Very Important): (912 354 78
Company: STEVE WHITE
Department/Floor No
Exact Street Address (We Cannot Deliver to P.O. Boxes or P.O. Zip Codes.): 5102 LAROCHE AVE
City: SAVANNAH
State: GA
ZIP Required: 31404

YOUR INTERNAL BILLING REFERENCE INFORMATION (optional) (First 24 characters will appear on invoice.)

H IF HOLD FOR PICK-UP, Print FEDEX Address Here
Street Address
City State ZIP Required

3 PAYMENT 1 [X] Bill Sender 2 [ ] Bill Recipient's FedEx Acct No 3 [ ] Bill 3rd Party FedEx Acct No 4 [ ] Bill Credit Card
[ ] Cash/Check [redacted]

4 SERVICES (Check only one box)

Priority Overnight (Delivery by next business morning)
11 [X] YOUR PACKAGING
16 [ ] FEDEX LETTER *
12 [ ] FEDEX PAK *
13 [ ] FEDEX BOX
14 [ ] FEDEX TUBE

Standard Overnight (Delivery by next business afternoon)
51 [ ] YOUR PACKAGING
56 [ ] FEDEX LETTER *
52 [ ] FEDEX PAK *
53 [ ] FEDEX BOX
54 [ ] FEDEX TUBE

Economy Two-Day (Delivery by second business day)
30 [ ] ECONOMY

Government Overnight (Restricted to authorized users only)
46 [ ] GOVT LETTER
41 [ ] GOVT PACKAGE

Freight Service (for Extra Large or any package over 150 lbs.)
70 [ ] OVERNIGHT FREIGHT **
80 [ ] TWO-DAY FREIGHT **
(Confirmed reservation required)
† Delivery commitment may be later in some areas
* Declared Value Limit $100
** Call for delivery schedule

5 DELIVERY AND SPECIAL HANDLING (Check services required)
1 [ ] HOLD FOR PICK-UP (Fill in Box H)
2 [X] DELIVER WEEKDAY
3 [ ] DELIVER SATURDAY (Extra charge) (Not available to all locations)
4 [ ] DANGEROUS GOODS (Extra charge)
5 [ ]
6 [ ] DRY ICE Lbs
7 [ ] OTHER SPECIAL SERVICE
8 [ ]
9 [ ] SATURDAY PICK-UP
10 [ ]
11 [ ]
12 [ ] HOLIDAY DELIVERY (If offered) (Extra charge)

6
PACKAGES	WEIGHT In Pounds Only	YOUR DECLARED VALUE
1	21	
1	21	
Total 2	Total 42	Total

DIM SHIPMENT (Chargeable Weight)
[ ] lbs
L x W x H

Received At
1 [ ] Regular Stop 3 [ ] Drop Box
2 [ ] On-Call Stop 4 [ ] B.S.C. 5 [X] Station

Emp. No. Date
[ ] Cash Received
[ ] Return Shipment
[ ] Third Party [ ] Chg. To Del. [ ] Chg. To Hold
Street Address
City State Zip
Received By:
X
Date/Time Received FedEx Employee Number

7 Release Signature:
FedEx Emp. No. Date/Time

Federal Express Use
Base Charges
Declared Value Charge
Other 1
Other 2
Total Charges

REVISION DATE 6/91
PART #137204 FXEM 2/92
FORMAT #099
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SL SAVANNAH LABORATORIES
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LOG NO: S2-41402

Received: 26 MAR 92

RECEIVED
APR 24 1992
McLAREN/HART

Mr. Roy Cox
McLaren Hart
29225 Chagrin Blvd.
Cleveland, OH 44122

Project: 080000103.004 Albion
Sampled By: Client

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , LIQUID SAMPLES	DATE SAMPLED
41402-1	P ~~B~~-19B	03-25-92
41402-2	B-32D	03-25-92
41402-3	B-32S	03-25-92
41402-4	B-101S	03-25-92
41402-5	B-101D	03-25-92

RLC

PARAMETER	41402-1	41402-2	41402-3	41402-4	41402-5
Purgeable Halocarbons (601)					
Trichloroethene, ug/l	2.1	88	54	27	<1.0
Surrogate - Bromochloromethane % Rec	59	59	63	63	67

SL SAVANNAH LABORATORIES
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LOG NO: S2-41402

Received: 26 MAR 92

Mr. Roy Cox
McLaren Hart
29225 Chagrin Blvd.
Cleveland, OH 44122

Project: 080000103.004 Albion
Sampled By: Client

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , LIQUID SAMPLES	DATE SAMPLED
41402-6	B-122S	03-25-92
41402-7	B-124S	03-25-92
41402-8	H-5D	03-25-92
41402-9	H-5S	03-25-92
41402-10	H-7S	03-25-92

PARAMETER	41402-6	41402-7	41402-8	41402-9	41402-10
Purgeable Halocarbons (601)					
Trichloroethene, ug/l	170	2200	<1.0	110	23
Surrogate - Bromochloromethane % Rec	59	63	61	62	58

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Received: 26 MAR 92

Mr. Roy Cox
McLaren Hart
29225 Chagrin Blvd.
Cleveland, OH 44122

Project: 080000103.004 Albion
Sampled By: Client

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , LIQUID SAMPLES	DATE SAMPLED
41402-11	H-7D	03-25-92
41402-12	H-10D	03-25-92
41402-13	H-10S	03-25-92
41402-14	H-11D	03-25-92
41402-15	H-11S	03-25-92

PARAMETER	41402-11	41402-12	41402-13	41402-14	41402-15
Purgeable Halocarbons (601)					
Trichloroethene, ug/l	<1.0	3.5	<1.0	<1.0	1.9
Surrogate - Bromochloromethane % Rec	63	56	69	62	62

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LOG NO: S2-41402

Received: 26 MAR 92

Mr. Roy Cox
McLaren Hart
29225 Chagrin Blvd.
Cleveland, OH 44122

Project: 080000103.004 Albion
Sampled By: Client

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , LIQUID SAMPLES	DATE SAMPLED
41402-16	H-12D	03-25-92
41402-17	H-14D Blind Replicate H-5S	03-25-92
41402-18	P-3	03-25-92
41402-19	P-3B	03-25-92
41402-20	P-11	03-25-92

PARAMETER	41402-16	41402-17	41402-18	41402-19	41402-20
Purgeable Halocarbons (601)					
Trichloroethene, ug/l	<1.0	84	91	130	14
Surrogate - Bromochloromethane % Rec	62	61	62	49	60

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LOG NO: S2-41402

Received: 26 MAR 92

Mr. Roy Cox
McLaren Hart
29225 Chagrin Blvd.
Cleveland, OH 44122

Project: 080000103.004 Albion
Sampled By: Client

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , LIQUID SAMPLES	DATE SAMPLED
41402-21	P-16	03-25-92
41402-22	P-16B	03-25-92
41402-23	P-19	03-25-92
41402-24	103-D	03-25-92
41402-25	Trip Blank TB-1	03-25-92

PARAMETER	41402-21	41402-22	41402-23	41402-24	41402-25
Purgeable Halocarbons (601)					
Trichloroethene, ug/l	500	620	250	240	<1.0
Surrogate - Bromochloromethane % Rec	60	59	57	61	60

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& ENVIRONMENTAL SERVICES, INC.

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Received: 26 MAR 92

Mr. Roy Cox
McLaren Hart
29225 Chagrin Blvd.
Cleveland, OH 44122

Project: 080000103.004 Albion
Sampled By: Client

REPORT OF RESULTS

LOG NO	SAMPLE DESCRIPTION , QC REPORT FOR LIQUID SAMPLES
41402-26	Method Blank-Water
41402-27	Accuracy (Mean % Recovery)-Water
41402-28	Precision (% RPD)-Water
41402-29	Date Analyzed-Water

PARAMETER	41402-26	41402-27	41402-28	41402-29
Purgeable Halocarbons (601)				
Trichloroethene, ug/l	<1.0	130 %	0 %	04.5-8.92

Methods: EPA 40 CFR Part 136

Steven J. White

Steven J. White

SL SAVANNAH LABORATORIES & ENVIRONMENTAL SERVICES, INC.

[X] 5102 LaRoche Avenue, Savannah, GA 31404 Phone: (912) 354-7858 Fax (912) 352-0165
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[ ] 6712 Benjamin Road, Suite 100, Tampa, FL 33634 Phone: (813) 885-7427 Fax (813) 885-7049

ALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

Cooler #1

NUMBER | PROJECT NUMBER: 08.0000103.004 | PROJECT NAME: Albion

MATRIX TYPE | REQUIRED ANALYSES | PAGE 1 OF 2

NT NAME: McLaren/Hart | TELEPHONE/FAX NO.: (216) 464-6564 Phone (216) 464-6101 Fax

NT ADDRESS: 9225 Chagrin Blvd | CITY, STATE, ZIP CODE: Cleveland, OH 44122

PLER(S) NAME(S): Roy L Cox | CLIENT PROJECT MANAGER: Roy L. Cox

[ ] STANDARD TAT
[ ] EXPEDITED TAT *

REPORT DUE DATE 4/15/92
* SUBJECT TO RUSH FEES

SAMPLING DATE	SAMPLING TIME	SAMPLE IDENTIFICATION	AQUEOUS MATRIX	NONAQUEOUS MATRIX	OIL MATRIX	AIR MATRIX	TCE by 601									
/23	17:24	B-109D	X				X									
/23	17:10	B-47D	X				X									
23	17:30	B-45S	X				X									
24	13:55	H-13S	X				X									
/24	15:10	B-104S	X				X									
/23	(5:34) 17:34	B-109S	X				X									
24	11:05	H-8S	X				X									
24	9:35	H-1S	X				X									
24	17:20	H-14S	X				X									
24	11:32	B-44D	X				X									
24	11:00	H-8D	X				X									
24	10:37	B-11S	X				X									

NUMBER OF CONTAINERS SUBMITTED

QUISHED BY: (SIGNATURE)	DATE	TIME	RECEIVED BY: (SIGNATURE)	DATE	TIME	RELINQUISHED BY: (SIGNATURE)	DATE	TIME
D. Dixon	3/17	1:00	Roy L Cox	3/23/92	8:00	Roy L Cox	3/24/92	17:30
IVED BY: (SIGNATURE)	DATE	TIME	RELINQUISHED BY: (SIGNATURE)	DATE	TIME	RECEIVED BY: (SIGNATURE)	DATE	TIME

FOR SAVANNAH LABORATORY USE ONLY

EIVED FOR LABORATORY BY: (SIGNATURE)	DATE	TIME	CUSTODY INTACT	CUSTODY SEAL NO.	S.L. LOG NO.	LABORATORY REMARKS
L. Bonds	3/25/92	9:45 am	[✓] YES [ ] NO		41373	

ORIGINAL

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- [ ] 414 Southwest 12th Avenue, Deerfield Beach, FL 33442 — Phone: (305) 421-7400 — Fax (305) 421-2584
- [ ] 900 Lakeside Drive, Mobile, AL 36693 — Phone: (205) 666-6633 — Fax (205) 666-6696
- [ ] 6712 Benjamin Road, Suite 100, Tampa, FL 33634 — Phone: (813) 885-7427 — Fax (813) 885-7049

ALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

Cooler #1

NUMBER	PROJECT NUMBER	PROJECT NAME	MATRIX TYPE	REQUIRED ANALYSES	PAGE	OF
	08,0000103,004	Albion (216) 464-5564 Phone (216) 464-6101 Fax			2	2

NT NAME: Mclaren/Hart — TELEPHONE/FAX NO.: (216)

NT ADDRESS: 25225 Chagrin Blvd. — CITY, STATE, ZIP CODE: Cleveland, OH 44122

PLER(S) NAME(S): Roy L. Cox — CLIENT PROJECT MANAGER: Roy L. Cox

- [ ] STANDARD TAT
- [ ] EXPEDITED TAT *

REPORT DUE DATE 4/15/92

* SUBJECT TO RUSH FEES

SAMPLING DATE	SAMPLING TIME	SAMPLE IDENTIFICATION	AQUEOUS MATRIX	NONAQUEOUS MATRIX	OIL MATRIX	AIR MATRIX	TCE by Method 601									
/23	12:05	B-46S	X				X									
24	9:25	H-2S	X				X									
24	8:53	H-4S	X				X									
24	10:25	B-102D	X				X									
24	16:00	B-29S	X				X									
24	12:55	H-2D	X				X									
24	10:10	H-1D	X				X									
/24		Trip Blank #1														

NUMBER OF CONTAINERS SUBMITTED

RELINQUISHED BY: (SIGNATURE)	DATE	TIME	RECEIVED BY: (SIGNATURE)	DATE	TIME	RELINQUISHED BY: (SIGNATURE)	DATE	TIME
[signature]	3/11	11:00	Roy L Cox	3/23	8:00	Roy L Cox	3/24	17:30
RECEIVED BY: (SIGNATURE)	**DATE**	**TIME**	**RELINQUISHED BY: (SIGNATURE)**	**DATE**	**TIME**	**RECEIVED BY: (SIGNATURE)**	**DATE**	**TIME**

FOR SAVANNAH LABORATORY USE ONLY

RECEIVED FOR LABORATORY BY: (SIGNATURE)	DATE	TIME	CUSTODY INTACT	CUSTODY SEAL NO.	S.L. LOG NO.	LABORATORY REMARKS
P. Bonds	3/25/92	9:45 am	[x] YES [ ] NO		41373	

ORIGINAL

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ALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

Cooler #2

NUMBER:
PROJECT NUMBER: ←
PROJECT NAME: Albion 08.0000/03.004
PAGE 1 OF 1

NT NAME: lcLaren Hart
TELEPHONE/FAX NO.: (216) 464-6564 Phone; (216) 464-6101 Fax
NT ADDRESS: 1225 Chagrin Blvd
CITY, STATE, ZIP CODE: Cleveland, Ohio 44122
PLER(S) NAME(S): Roy L. Cox
CLIENT PROJECT MANAGER: Roy L. Cox

[X] STANDARD TAT
[ ] EXPEDITED TAT *
REPORT DUE DATE 4/13/92
* SUBJECT TO RUSH FEES

REQUIRED ANALYSES: TCE by Method 601

SAMPLING DATE	TIME	SAMPLE IDENTIFICATION	AQUEOUS MATRIX	NONAQUEOUS MATRIX	OIL MATRIX	AIR MATRIX	TCE by Method 601
24	16:32	B-28D	X				X
24	16:55	H-9S	X				X
24	16:30	H-9D	X				X
		Trip Bank #2	X				X
24	11:30	B-110S	X				X
24	16:04	B-31S	X				X
24	14:25	H-13D	X				X
24	14:25	H-6D	X				X
24	15:42	B-28S	X				X
24	14:05	H-6S	X				X
24	15:20	B-110D	X				X
24	17:20	B-106D	X				X
4	17:20	B-45D	X				X

NUMBER OF CONTAINERS SUBMITTED

INQUISHED BY: (SIGNATURE)	DATE	TIME	RECEIVED BY: (SIGNATURE)	DATE	TIME	RELINQUISHED BY: (SIGNATURE)	DATE	TIME
[signature]	03/17	4:00	Roy L Cox	3/23	8:00	Roy L Cox	3/24	17:30
EIVED BY: (SIGNATURE)	DATE	TIME	RELINQUISHED BY: (SIGNATURE)	DATE	TIME	RECEIVED BY: (SIGNATURE)	DATE	TIME

FOR SAVANNAH LABORATORY USE ONLY

EIVED FOR LABORATORY BY: (SIGNATURE)	DATE	TIME	CUSTODY INTACT	CUSTODY SEAL NO.	S.L. LOG NO.
L. Bonds	3/25/92	9:45 am	[✓] YES [ ] NO		41373

LABORATORY REMARKS

ORIGINAL

SL **SAVANNAH LABORATORIES & ENVIRONMENTAL SERVICES, INC.**

[X] 5102 LaRoche Avenue, Savannah, GA 31404 Phone: (912) 354-7858 Fax (912) 352-0165
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[ ] 900 Lakeside Drive, Mobile, AL 36693 Phone: (205) 666-6633 Fax (205) 666-6696
[ ] 6712 Benjamin Road, Suite 100, Tampa, FL 33634 Phone: (813) 885-7427 Fax (813) 885-7049

ALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

NUMBER:)
PROJECT NUMBER: 0320203 004
PROJECT NAME: ALBION
NT NAME: McLAREN/HART
TELEPHONE/FAX NO.: 216 464-6121 FAX; 216 464-6564 PHONE
NT ADDRESS / CITY, STATE, ZIP CODE: 25 CHAGRIN BLVD CLEVELAND, OH 44122
PLER(S) NAME(S): Cox
CLIENT PROJECT MANAGER: Roy Cox

MATRIX TYPE: AQUEOUS MATRIX, NONAQUEOUS MATRIX, OIL MATRIX, AIR MATRIX

REQUIRED ANALYSES: ICE; BY EPA 601

PAGE 1 OF 2

[ ] STANDARD TAT
[ ] EXPEDITED TAT *
REPORT DUE DATE 4/15/92
* SUBJECT TO RUSH FEES

NUMBER OF CONTAINERS SUBMITTED

SAMPLING DATE	SAMPLING TIME	SAMPLE IDENTIFICATION	AQUEOUS MATRIX	NONAQUEOUS MATRIX	OIL MATRIX	AIR MATRIX	ICE BY EPA 601
/92	12:45	P-3	X				X
3/92	12:30	P-3B	X				X
/92	12:07	P-11	X				X
/92	12:25	103-D	X				X
/92	10:24	B-32D	X				X
/92	15:25	H-12D	X				X
/92	15:10	B-12S	X				X
/92	15:35	H-11D	X				X
/92	10:50	P ~~B~~-19B	X				X
/92	10:20	B-32S	X				X
/92	11:02	P-16	X				X
/92	11:10	P-16B	X				X

INQUISHED BY: (SIGNATURE)	DATE	TIME	RECEIVED BY: (SIGNATURE)	DATE	TIME	RELINQUISHED BY: (SIGNATURE)	DATE	TIME
C. Dacon	3/17	4:00	Roy R. Cox	3/24	8:00	Roy R. Cox	3/25	17:20
EIVED BY: (SIGNATURE)	DATE	TIME	RELINQUISHED BY: (SIGNATURE)	DATE	TIME	RECEIVED BY: (SIGNATURE)	DATE	TIME

FOR SAVANNAH LABORATORY USE ONLY

EIVED FOR LABORATORY BY: (SIGNATURE)	DATE	TIME	CUSTODY INTACT	CUSTODY SEAL NO.	S.L. LOG NO.	LABORATORY REMARKS
T. Johnson	3/26/92	10:15	[X] YES [ ] NO		41402	

ORIGINAL

SL SAVANNAH LABORATORIES & ENVIRONMENTAL SERVICES, INC.

☒ 5102 LaRoche Avenue, Savannah, GA 31404 Phone: (912) 354-7858 Fax (912) 352-0165
☐ 2846 Industrial Plaza Drive, Tallahassee, FL 32301 Phone: (904) 878-3994 Fax (904) 878-9504
☐ 414 Southwest 12th Avenue, Deerfield Beach, FL 33442 Phone: (305) 421-7400 Fax (305) 421-2584
☐ 900 Lakeside Drive, Mobile, AL 36693 Phone: (205) 666-6633 Fax (205) 666-6696
☐ 6712 Benjamin Road, Suite 100, Tampa, FL 33634 Phone: (813) 885-7427 Fax (813) 885-7049

ALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

NUMBER | PROJECT NUMBER: 0820005103.004 | PROJECT NAME: ALBION

NT NAME: MCLAREN/HART | TELEPHONE/FAX NO.: 216 464-6564 PH# / 464-6101 FAX

NT ADDRESS: 1225 CHAGRIN BLVD | CITY, STATE, ZIP CODE: CLEVELAND, OHIO 44122

PLER(S) NAME(S): Cox | CLIENT PROJECT MANAGER: Roy Cox

PAGE 2 OF 2

REQUIRED ANALYSES: TCE BY EPA 601

☐ STANDARD TAT
☐ EXPEDITED TAT *

REPORT DUE DATE 4/15/92

* SUBJECT TO RUSH FEES

SAMPLING ATE	TIME	SAMPLE IDENTIFICATION	AQUEOUS MATRIX	NONAQUEOUS MATRIX	OIL MATRIX	AIR MATRIX	TCE BY EPA 601
/92	09:13	B-101D	X				X
/92	09:07	B-101S	X				X
/92	14:57 ~~12:45~~	B-124S	X				X
/92	10:45	P-19	X				X
/92		H-5D	X				X
/92	12:25	H-10S	X				
/92	10:00	H-11S	X				
/92	16:00	H-14D	X				
/92	15:00	H-5S	X				
/92	12:15	H-10D	X				
/92		H-7S	X				
/92	17:00	H-7D	X				
/92		TRIP BLANK #					

NUMBER OF CONTAINERS SUBMITTED

NQUISHED BY: (SIGNATURE)	DATE	TIME	RECEIVED BY: (SIGNATURE)	DATE	TIME	RELINQUISHED BY: (SIGNATURE)	DATE	TIME
[signature]	3/1?	?	[signature]	3/24	8:00	[signature]	3/25	17:20
EIVED BY: (SIGNATURE)	**DATE**	**TIME**	**RELINQUISHED BY: (SIGNATURE)**	**DATE**	**TIME**	**RECEIVED BY: (SIGNATURE)**	**DATE**	**TIME**

FOR SAVANNAH LABORATORY USE ONLY

EIVED FOR LABORATORY BY: (SIGNATURE)	DATE	TIME	CUSTODY INTACT	CUSTODY SEAL NO.	S.L. LOG NO.	LABORATORY REMARKS
L. Johnson	3/26/92	10:15	☒ YES ☐ NO		41402	

ORIGINAL

[redacted]

QUESTIONS? CALL 800-238-5355 TOLL FREE.

AIRBILL
PACKAGE TRACKING NUMBER 2162603321

2162603321

S7-41402

RECIPIENT'S COPY

[redacted] Date 3/25/92

1 From (Your Name) Please Print: ROY COX
Your Phone Number (Very Important): (216) 4646564
Department/Floor No
Company: [illegible]/HART ENVIRONMENTAL
Street Address: [illegible] CHAGRIN BLVD 3RD FL
City: CLE[illegible]AND State: [illegible] ZIP Required: 44122

2 To (Recipient's Name) Please Print: STEVE WHITE
Recipient's Phone Number (Very Important): (912) 354-7858
Department/Floor No
Company: SAVANNAH LABS
Exact Street Address (We Cannot Deliver to P.O. Boxes or P.O. Zip Codes): 5102 LAROCHE AVE
City: SAVANNAH State: GA ZIP Required: 31404

YOUR INTERNAL BILLING REFERENCE INFORMATION (optional) (First 24 characters will appear on invoice.)

H IF HOLD FOR PICK-UP, Print FEDEX Address Here
Street Address
City State ZIP Required

3 PAYMENT 1 [X] Bill Sender 2 [ ] Bill Recipient's FedEx Acct No 3 [ ] Bill 3rd Party FedEx Acct No 4 [ ] Bill Credit Card
5 [ ] Cash/Check [redacted]

4 SERVICES (Check only one box)

Priority Overnight (Delivery by next business morning)
11 [X] YOUR PACKAGING
16 [ ] FEDEX LETTER *
12 [ ] FEDEX PAK *
13 [ ] FEDEX BOX
14 [ ] FEDEX TUBE

Standard Overnight (Delivery by next business afternoon)
51 [ ] YOUR PACKAGING
56 [ ] FEDEX LETTER *
52 [ ] FEDEX PAK *
53 [ ] FEDEX BOX
54 [ ] FEDEX TUBE

Economy Two Day (Delivery by second business day)
30 [ ] ECONOMY

Government Overnight
46 [ ] GOVT LETTER
41 [ ] GOVT PACKAGE

Freight Service
70 [ ] OVERNIGHT FREIGHT **
80 [ ] TWO-DAY FREIGHT **

*Declared Value Limit $100
**Call for delivery schedule

5 DELIVERY AND SPECIAL HANDLING (Check services required)
1 [ ] HOLD FOR PICK-UP (Fill in Box H)
2 [X] DELIVER WEEKDAY
3 [ ] DELIVER SATURDAY (Extra charge)
4 [ ] DANGEROUS GOODS (Extra charge)
5 [ ]
6 [ ] DRY ICE lbs
7 [ ] OTHER SPECIAL SERVICE
8 [ ]
9 [ ] SATURDAY PICK-UP
10 [ ]
11 [ ]
12 [ ] HOLIDAY DELIVERY (If offered)

6 PACKAGES: 1 WEIGHT In Pounds: 25 YOUR DECLARED VALUE
Total: 1 Total: 25 Total

DIM SHIPMENT (Chargeable Weight) [ ] lbs
L x W x H =

Received At
1 [ ] Regular Stop 3 [ ] Drop Box
2 [ ] On-Call Stop 4 [ ] B.S.C. 5 [X] Station

Emp. No. Date
[ ] Cash Received
[ ] Return Shipment
[ ] Third Party [ ] Chg To Del [ ] Chg To Hold
Street Address
City State Zip
Received By: X
Date/Time Received FedEx Employee Number

7 Release Signature:
FedEx Emp. No. Date/Time

Federal Express Use
Base Charges
Declared Value Charge
Other 1
Other 2
Total Charges

REVISION DATE 6/91
PART #[illegible]
FORMAT #099
099
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UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

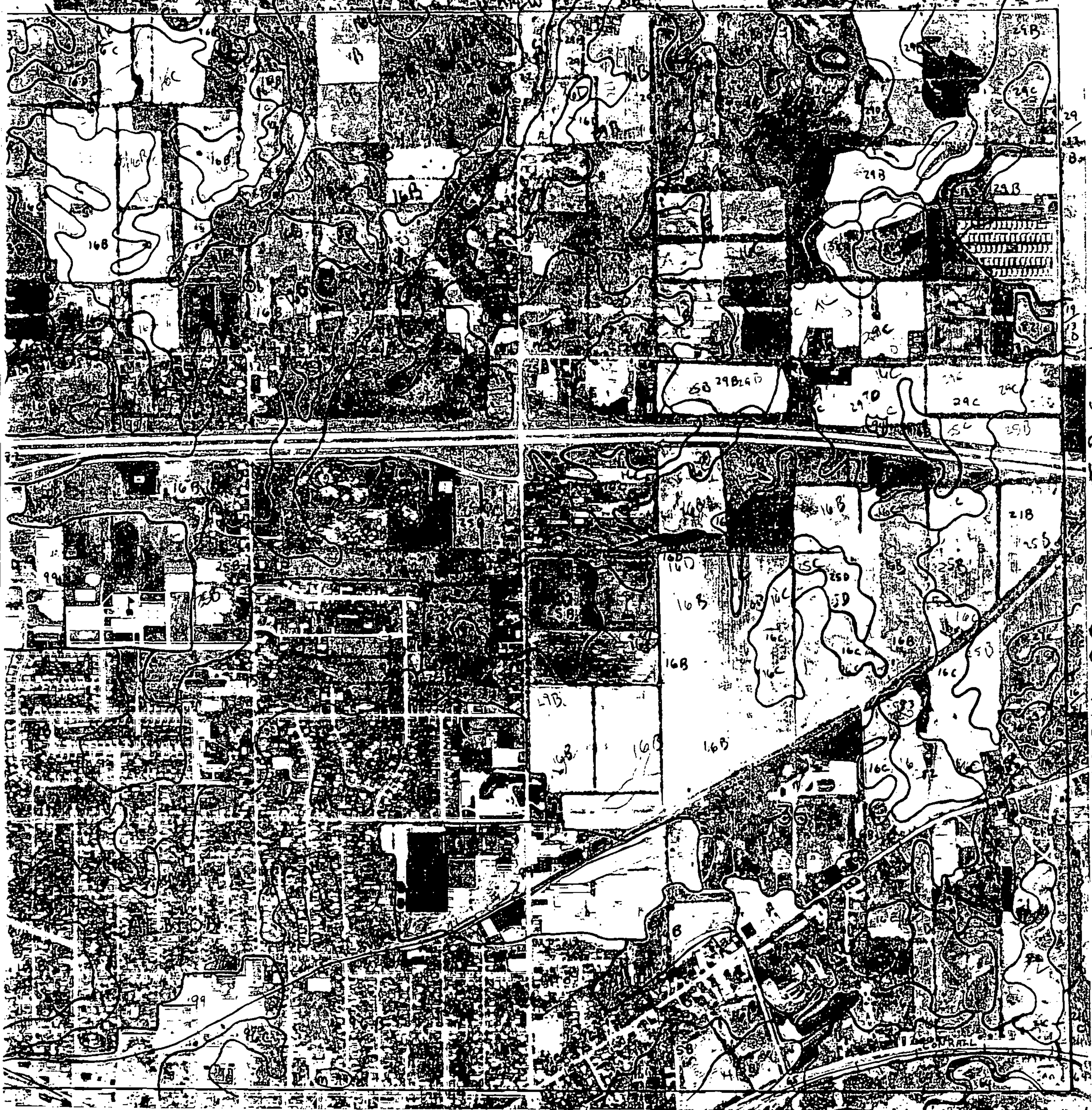
OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE, $300

CALHOUN COUNTY SOIL SURVEY
c/o Office of Facilities/Planning
Calhoun County Building
315 West Green Street
Marshall, Michigan 49068

Rec'd 1/24/92

James Rossi
W W Engineering and Science
5555 Glenwood Hills Parkway, SE
P.O. Box. 874
Grand Rapids MI
49588-0874

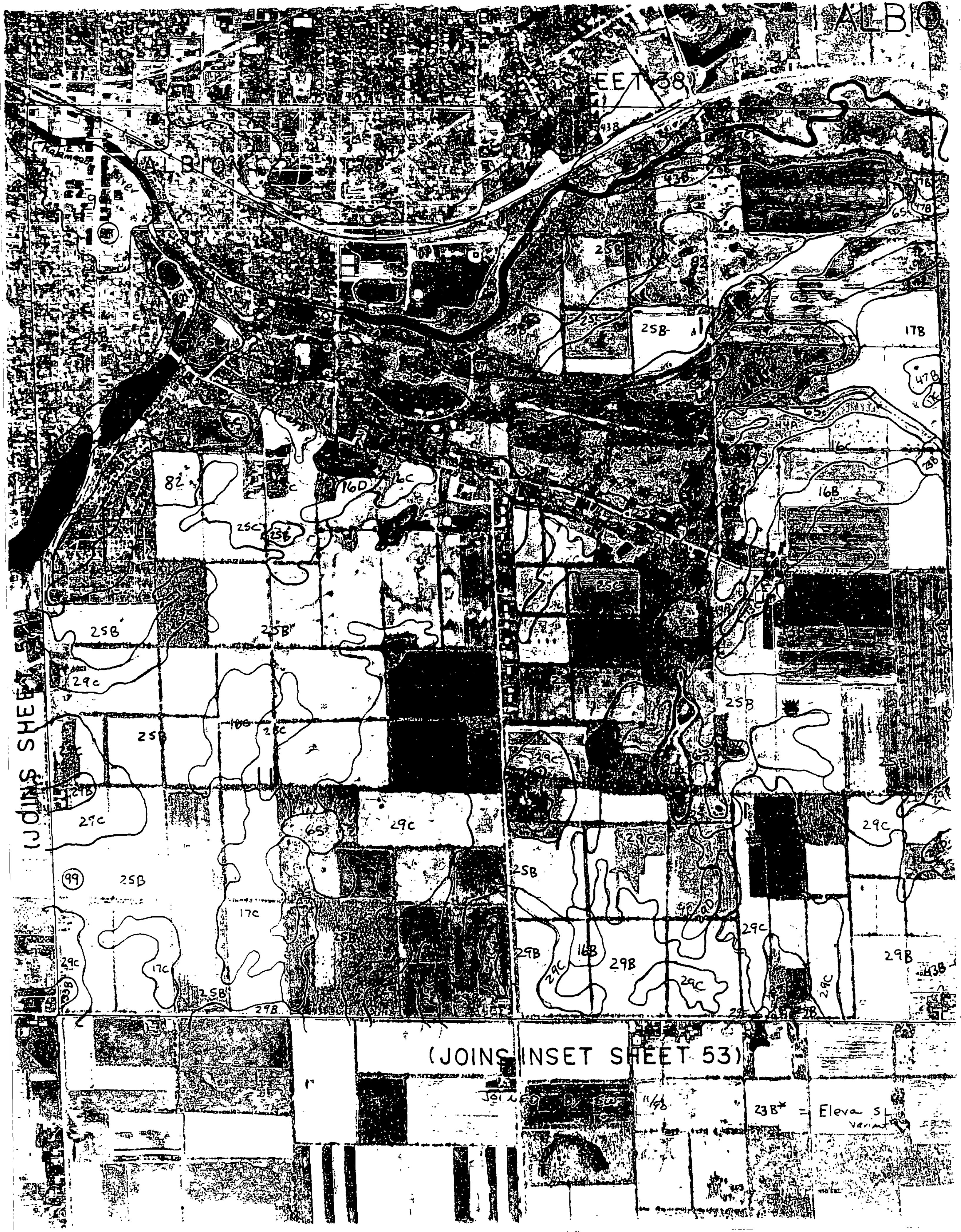
(JOINS SHEET 38)



(JOINS SHEET 53)

Joined 12/9/91 [illegible]

CALHOUN COUNTY, MICHIGAN
SCS Atlas Sheet No. 38 Scale 1:15,840



ALBIO
SHEET 38)
ALBION
(JOINS INSET SHEET 53)
(JOINS SHE
23B* = Eleva SL variant
25B
17B
47B
65
16B
82
16D
25C
29C
29B
17C
99
43B
44A

SCS-SOILS-37A
3-75

CONVENTIONAL AND SPECIAL SYMBOLS LEGEND

U.S. DEPARTMENT OF AGRICU
SOIL CONSERVATION SE

Soil Survey Area: ____________
State: ____________

Date: ____________

DESCRIPTION	SYMBOL

CULTURAL FEATURES

BOUNDARIES

- National, state, or province
- County or parish
- Minor civil division
- Field sheet matchline & neatline

AD HOC BOUNDARY (label)

- Small airport, airfield, park, oilfield, cemetery, or flood pool

STATE COORDINATE TICK — 1 890 000 FEET

LAND DIVISION CORNERS (sections and land grants)

ROADS

- Divided (median shown if scale permits)
- County, farm or ranch
- Trail

ROAD EMBLEMS & DESIGNATIONS

- Interstate — 86
- Federal — 287
- State — 52
- Other — 398

RAILROAD

LEVEES

- Without road

DAMS

- Large (to scale)
- Medium or small — W

PITS

- Gravel pit
- Mine or quarry

DESCRIPTION	SYMBOL

CULTURAL FEATURES (cont.)

MISCELLANEOUS CULTURAL FEATURES

- Farmstead, house (omit in urban areas)
- Church
- School
- Indian mound (label)

WATER FEATURES

DRAINAGE

- Perennial, double line
- Perennial, single line
- Intermittent
- Drainage end
- Canals or ditches
- Drainage and/or irrigation

LAKES, PONDS AND RESERVOIRS

- Perennial

MISCELLANEOUS WATER FEATURES

- Marsh or swamp
- Spring
- Wet spot

DESCRIPTION	SYMBOL

SPECIAL SYMBOLS FOR SOIL SURVEY

SOIL DELINEATIONS AND SOIL SYMBOLS — CeA FoB2

ESCARPMENTS

- Bedrock (points down slope)
- Other than bedrock (points down slope)

SHORT STEEP SLOPE

GULLY

DEPRESSION OR SINK

MISCELLANEOUS

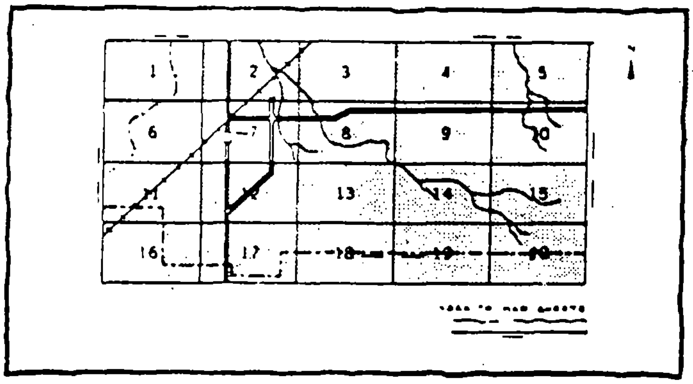
- Blowout
- Clay spot
- Gravelly spot
- Dumps and other similar non soil areas
- Rock outcrop (includes sandstone and shale)
- Sandy spot
- Severely eroded spot
- Stony spot, very stony spot

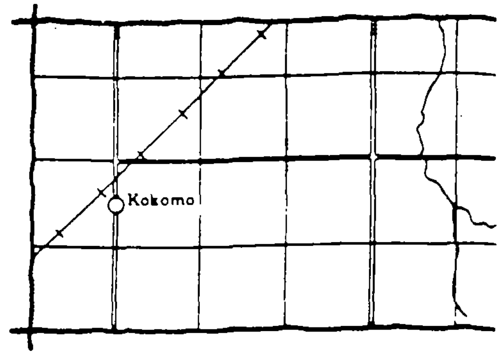
RECOMMENDED AD HOC SOIL SYMBOLS

- Marl
- WET DEPRESSION
- LOAMY SPOT
- ORGANIC SPOT
- MINERAL SPOT

How to use this survey

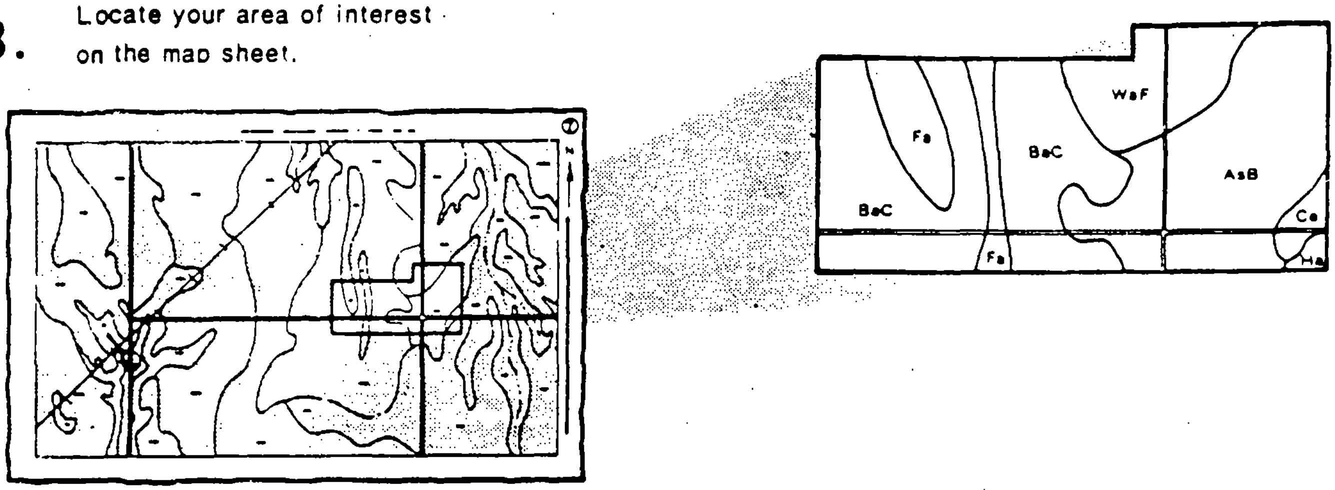
1. Locate your area of interest on the "Index to Map Sheets" (page IV of this publication).



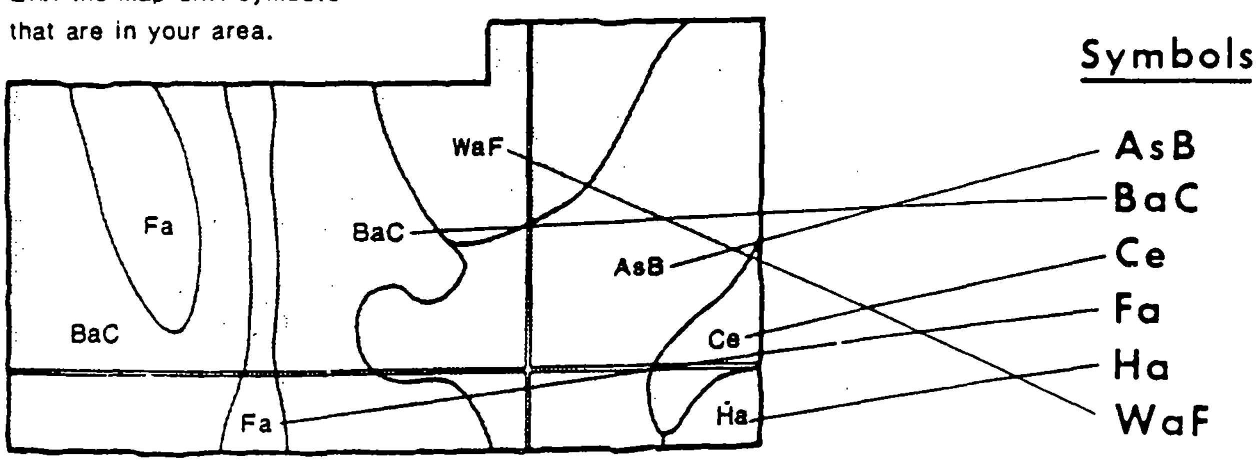


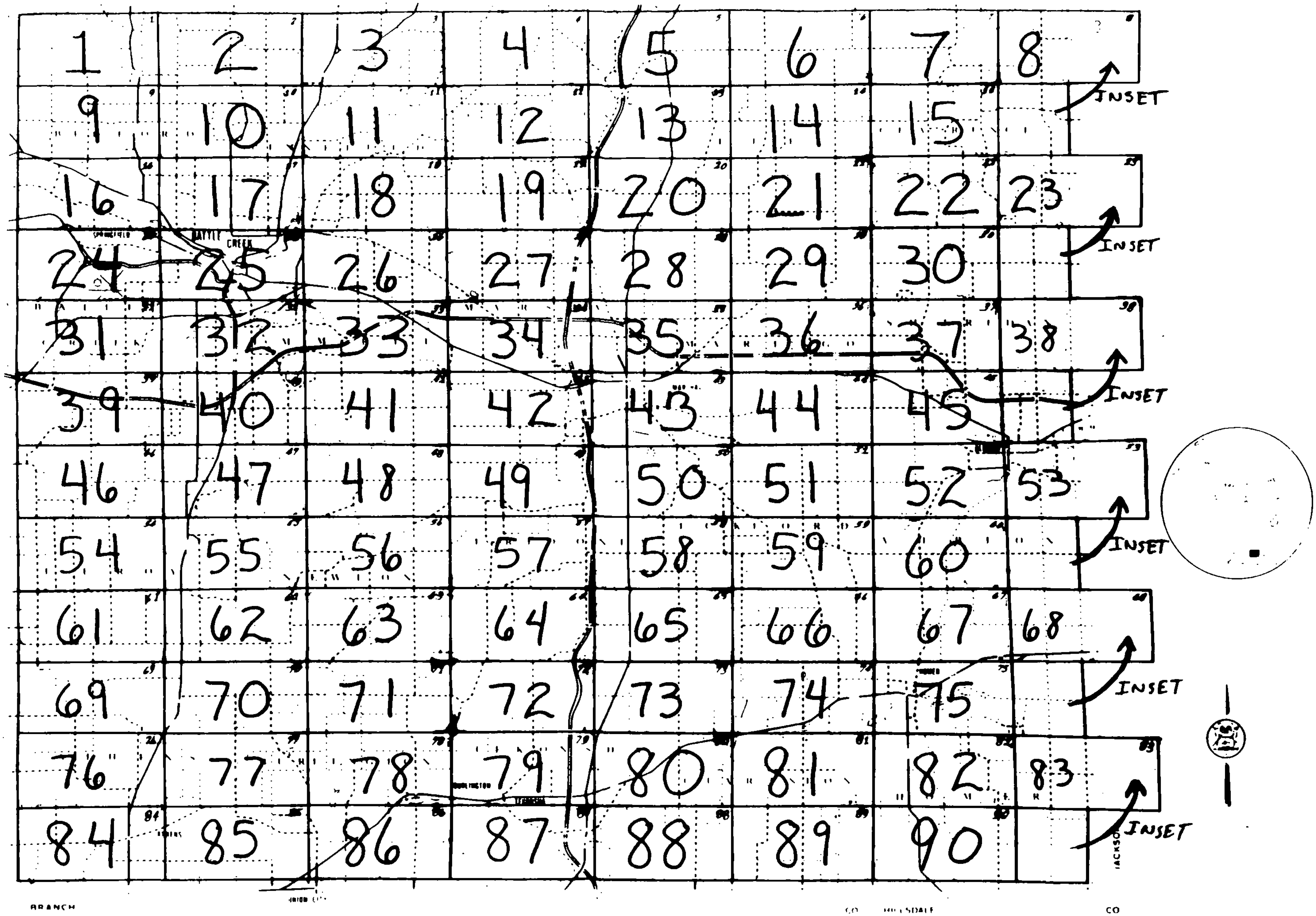
2. Note the number of the map atlas sheet and turn to that sheet.

3. Locate your area of interest on the map sheet.



4. List the map unit symbols that are in your area.





INDEX TO MAP SHEETS
CALHOUN COUNTY, MICHIGAN
JOB NUMBER: 26025
PUBLICATION SCALE 1:15,840
FORMAT 2 x 4 SECTIONS

GENERAL HIGHWAY MAP

CALHOUN COUNT'

MICHIGAN

STATE HIGHWAY COMMISSION

Soil Survey Identification Legend
Calhoun County, Michigan
December 20, 1991

Map Unit Symbol		Field Name
2		Houghton muck
4		Adrian muck
5	(6)	Palms muck
7		Houghton muck, drained
8		Edwards muck
9		Martisco muck
12B	(11B)	Coloma loamy sand, 0 to 6 percent slopes
12C		Coloma loamy sand, 6 to 12 percent slopes
12D		Coloma loamy sand, 12 to 18 percent slopes
12E		Coloma loamy sand, 18 to 40 percent Slopes
13B	(19B)	Spinks loamy sand, 0 to 6 percent slopes
13C	(19C)	Spinks loamy sand, 6 to 12 percent slopes
13D		Spinks loamy sand, 12 to 18 percent slopes
13E		Spinks loamy sand, 18 to 40 percent slopes
14B		Bronson sandy loam, 0 to 6 percent slopes
16B		Oshtemo sandy loam, 0 to 6 percent slopes
16C		Oshtemo sandy loam, 6 to 12 percent slopes
16D		Oshtemo sandy loam, 12 to 18 percent slopes
16E		Oshtemo sandy loam, 18 to 40 percent slopes
17B		Boyer sandy loam, 0 to 6 percent slopes
17C		Boyer sandy loam, 6 to 12 percent slopes
17D		Boyer sandy loam, 12 to 18 percent slopes
17E		Boyer sandy loam, 18 to 40 percent slopes
21B		Leoni gravelly loam, 0 to 6 percent slopes
21C		Leoni gravelly loam, 6 to 12 percent slopes
22A		Dowagiac loam, 0 to 2 percent slopes
23B		Hixton loam, 0 to 6 percent slopes
25A		Kalamazoo loam, 0 to 2 percent slopes
25B		Kalamazoo loam, 2 to 6 percent slopes
25C		Kalamazoo loam, 6 to 12 percent slopes
25D		Kalamazoo loam, 12 to 18 percent slopes
28B		Elmdale sandy loam, 2 to 6 percent slopes
29B		Hillsdale sandy loam, 0 to 6 percent slopes
29C		Hillsdale sandy loam, 6 to 12 percent slopes
29D		Hillsdale sandy loam, 12 to 18 percent slopes
29E		Hillsdale sandy loam, 18 to 25 percent slopes
33B		Riddles loam, 0 to 6 percent slopes
33C		Riddles loam, 6 to 12 percent slopes
33E		Riddles loam, 12 to 30 percent slopes
38B		Glynwood loam, 0 to 6 percent slopes
39B		Morley loam, 2 to 6 percent slopes
39C		Morley loam, 6 to 12 percent slopes
39D		Morley loam, 12 to 18 percent slopes
43B	(41A)(43A)	Brady sandy loam, 1 to 4 percent slopes
44A		Matherton loam, 0 to 3 percent slopes

Map Unit Symbol		Field Name
45A		Sleeth loam, 0 to 3 percent slopes
46B		Crosier loam, 1 to 4 percent slopes
47B		Teasdale sandy loam, 1 to 4 percent slopes
53A		Kibbie loam, 0 to 2 percent slopes
58B		Blount loam, 1 to 4 percent slopes
61		Glendora mucky sand (Algansee?)
62		Granby mucky loamy sand
63		Gilford sandy loam
64	(92)	Wallkill mucky loam
65		Sebewa loam
66		Sebewa loam, clay substratum
72		Barry mucky loam
73		Pella silt loam
78		Pewamo clay loam
82		Udipsamments and Udorthents, nearly level to steep
83		Pits, sand and gravel
84		Histosols and Aquents, ponded
85		Histosols and Fluvaquents, frequently flooded
90B		Coloma - Boyer complex, 0 to 6 percent slopes
90C		Coloma - Boyer complex, 6 to 12 percent slopes
90D		Coloma - Boyer complex, 12 to 18 percent slopes
95B		Urban land - Kalamazoo complex, 0 to 6 percent slopes
95C		Urban land - Kalamazoo complex, 6 to 12 percent slopes
96B		Urban land - Oshtemo complex, 0 to 6 percent slopes
96C		Urban land - Oshtemo complex, 6 to 12 percent slopes
96D		Urban land - Oshtemo complex, 12 to 18 percent slopes
99		Urban land
113B		Urban land - Coloma complex, 0 to 6 percent slopes
113C		Urban land - Coloma complex, 6 to 12 percent slopes

EXPLANATION OF KEY PHRASES USED ON SOIL INTERPRETATION RECORDS

	Explanation
AREA RECLAIM	An area difficult to reclaim after the removal of soil for construction and other uses.
CEMENTED PAN	Cemented pan too close to surface.
COMPLEX SLOPE	Irregular or variable slope. Planning or constructing terraces, diversions and water control measures on a complex slope is difficult.
CUTBANKS CAVE	The walls of excavations tend to cave in or slough.
DEEP TO WATER	Deep to permanent water table during dry season.
DENSE LAYER	A very firm, massive layer that has a bulk density of more than 1.8 grams per cubic centimeter. Such a layer affects the ease of digging and can affect filling and compacting.
DEPTH TO ROCK	Bedrock too near to the surface for the specific use.
DROUGHTY	Soils hold too little water for plants during dry periods.
DUSTY	Soil particles detach easily and cause dust.
ERODES EASILY	Water erodes soil easily.
EXCESS FINES	The soil contains too much silt and clay. The soil does not provide a source of gravel or sand for construction purposes.
EXCESS HUMUS	Too much organic matter.
FAST INTAKE	The rapid movement of water into the soil.
FAVORABLE	Features of the soil are favorable for the intended use.
FLOODING	Soil flooded by moving water from stream overflow or runoff.
FROST ACTION	Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other structures.
HARD TO PACK	Difficult to compact.
LARGE STONES	Rock fragments 3 inches or more across. Large stones adversely affect the specified use of the soil.
LOW STRENGTH	Not enough strength to adequately support the load.
NO WATER	Too deep to ground water.
PERCS SLOWLY	The slow movement of water through the soil adversely affecting the specified use.
PIPING	Water may form tunnels or pipelike cavities.
PONDING	Standing water on soils in closed depressions. The water can be removed only by percolation or evapotranspitation.
POOR FILTER	Because of rapid permeability, the soil may not adequately filter effluent from a waste disposal system.
POOR OUTLETS	Difficult or expensive to install outlets for drainage.
ROOTING DEPTH	Soil is thin over layer that restricts root growth.
SEEPAGE	Water moves through soil too fast.
SHRINK-SWELL	Soil expands significantly on wetting and shrinks on drying.
SLOPE	Slope is great enough that special practices are required to ensure satisfactory performance of the soil for a specific use.
SLOW INTAKE	Water infiltration restricted.
SLOW REFILL	Ponds fill slowly because of restricted soil permeability.
SMALL STONES	Contains many rock fragments less than 3 inches in diameter.
SOIL BLOWING	Soil easily moved and deposited by wind.
THIN LAYER	Inadequate thickness of suitable soil.
TOO CLAYEY	Soil slippery and sticky when wet and slow to dry.
TOO SANDY	Soil soft and loose, droughty and low in fertility.
UNSTABLE FILL	Banks of fills likely to cave or slough.
WETNESS	Soil wet during period of use.

MLRA(S): 95B, 97, 98, 99, 101, 103, 105, 100, 140, 148
REV. LWB, 7-89
TERRIC MEDISAPRISTS, SANDY OR SANDY-SKELETAL, MIXED, EUIC, MESIC

THE ADRIAN SERIES CONSISTS OF VERY POORLY DRAINED SOILS FORMED IN DEPOSITS OF ORGANIC MATERIAL OVER SANDY SEDIMENTS IN DEPRESSIONAL AREAS WITHIN LAKE PLAINS, TILL PLAINS AND MORAINES. THE SURFACE SOIL IS BLACK MUCK 34 INCHES THICK. THE SUBSTRATUM IS GRAY MOTTLED SAND. SLOPES ARE 0 TO 2 PERCENT. MOST AREAS ARE IN NATIVE VEGETATION.

LANDSCAPE AND CLIMATE PROPERTIES

ANNUAL AIR TEMPERATURE	FROST FREE DAYS	ANNUAL PRECIPITATION	ELEVATION (FT)	DRAINAGE CLASS	SLOPE (PCT)
47-52	130-170	30-36	600-1000	VP	0-2

ESTIMATED SOIL PROPERTIES

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT. >10 IN (PCT)	FRACT. 3-10 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	CLAY (PCT)
0-34	MUCK	PT	A-8							-
34-60	S, FS, GR-LS	SP, SM	A-2, A-3, A-1	0	0	80-100	60-100	30-80	0-35	2-10

DEPTH (IN.)	LIQUID LIMIT	PLASTICITY INDEX	MOIST BULK DENSITY (G/CM3)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SAR	CEC (ME/100G)	CACO3 (PCT)	GYPSUM (PCT)
0-34			0.30-0.55	0.2-6.0	0.35-0.45	5.1-7.3	-	-	150-200	-	-
34-60	-	NP	1.40-1.75	6.0-20	0.03-0.08	5.6-8.4	-	-	1-3	0-1	-

DEPTH (IN.)	ORGANIC MATTER (PCT)	SHRINK-SWELL POTENTIAL	EROSION FACTORS K	T	WIND EROD. GROUP	WIND EROD. INDEX	CORROSIVITY STEEL	CONCRETE
0-34	35-75		-	4	2	134	HIGH	MODERATE
34-60	-	LOW	.15					

FLOODING FREQUENCY	DURATION	MONTHS	HIGH WATER TABLE DEPTH (FT)	KIND	MONTHS	CEMENTED PAN DEPTH (IN)	HARDNESS	BEDROCK DEPTH (IN)	HARDNESS	SUBSIDENCE INIT. (IN)	TOTAL (IN)	HYD GRP	POTENT'L FROST ACTION
NONE			+1-1.0	APPARENT	NOV-MAY	-		>60			29-33	A/D	HIGH

SANITARY FACILITIES

SEPTIC TANK ABSORPTION FIELDS	SEVERE-SUBSIDES,PONDING,PERCS SLOWLY
SEWAGE LAGOON AREAS	SEVERE-SEEPAGE,EXCESS HUMUS,PONDING
SANITARY LANDFILL (TRENCH)	SEVERE-SEEPAGE,PONDING,TOO SANDY
SANITARY LANDFILL (AREA)	SEVERE-SEEPAGE,PONDING
DAILY COVER FOR LANDFILL	POOR-SEEPAGE,TOO SANDY,PONDING

BUILDING SITE DEVELOPMENT

SHALLOW EXCAVATIONS	SEVERE-CUTBANKS CAVE,EXCESS HUMUS,PONDING
DWELLINGS WITHOUT BASEMENTS	SEVERE-SUBSIDES,PONDING,LOW STRENGTH
DWELLINGS WITH BASEMENTS	SEVERE-SUBSIDES,PONDING
SMALL COMMERCIAL BUILDINGS	SEVERE-SUBSIDES,PONDING,LOW STRENGTH
LOCAL ROADS AND STREETS	SEVERE-SUBSIDES,PONDING,FROST ACTION
LAWNS, LANDSCAPING AND GOLF FAIRWAYS	SEVERE-PONDING,EXCESS HUMUS

CONSTRUCTION MATERIAL

ROADFILL	POOR-WETNESS
SAND	PROBABLE
GRAVEL	IMPROBABLE-TOO SANDY
TOPSOIL	POOR-EXCESS HUMUS,WETNESS

WATER MANAGEMENT

POND RESERVOIR AREA	SEVERE-SEEPAGE
EMBANKMENTS DIKES AND LEVEES	SEVERE-SEEPAGE,PIPING,PONDING
EXCAVATED PONDS AQUIFER FED	SEVERE-SLOW REFILL,CUTBANKS CAVE
DRAINAGE	PONDING,SUBSIDES,FROST ACTION
IRRIGATION	PONDING,SOIL BLOWING,ROOTING DEPTH
TERRACES AND DIVERSIONS	PONDING,TOO SANDY,SOIL BLOWING
GRASSED WATERWAYS	WETNESS,ROOTING DEPTH

MI0123 SOIL INTERPRETATIONS RECORD

MLR (S): 90, 91, 96, 97, 98, 99, 103, 104, 105
REV LWB, 1-91
AQUIC UDIPSAMMENTS, MIXED, MESIC

THE ALGANSEE SERIES CONSISTS OF VERY DEEP, SOMEWHAT POORLY DRAINED SOILS FORMED IN SANDY ALLUVIUM ON BOTTOMLANDS. THE SURFACE LAYER IS VERY DARK GRAYISH BROWN LOAMY SAND 10 INCHES THICK. THE SUBSTRATUM IS GRAYISH BROWN, BROWN AND VERY GRAY RWON FINE SAND AND SAND. SLOPES RANGE FROM 0 TO 4 PERCENT. MOST AREAS ARE USED FOR WOODLAND OR PASTURELAND.

LANDSCAPE AND CLIMATE PROPERTIES

ANNUAL AIR TEMPERATURE	FROST FREE DAYS	ANNUAL PRECIPITATION	ELEVATION (FT)	DRAINAGE CLASS	SLOPE (PCT)
47-50	130-180	28-36	600-900	SP	0-4

ESTIMATED SOIL PROPERTIES

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT. >10 IN (PCT)	FRACT. 3-10 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	CLAY (PCT)
0-10	LS, LFS	SM, SC-SM	A-2-4	0	0	100	100	50-75	15-35	0-15
0-10	SL, FSL	SM, SC-SM, ML, CL-ML	A-2-4, A-4	0	0	100	100	60-90	30-65	5-15
0-10	S, FS	SM, SP-SM	A-3, A-2-4	0	0	100	100	50-70	5-15	0-10
10-60	SR-S-L	SM, SP-SM	A-3, A-2-4	0	0	100	100	50-80	5-35	0-18

DEPTH (IN.)	LIQUID LIMIT	PLASTICITY INDEX	MOIST BULK DENSITY (G/CM3)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SAR	CEC (ME/100G)	CACO3 (PCT)	GYPSUM (PCT)
0-10	<25	NP-7	1.35-1.50	6.0-20	0.10-0.12	4.5-7.8	-	-	3-10	-	-
0-10	<25	NP-7	1.35-1.50	2.0-6.0	0.12-0.14	4.5-7.8	-	-	6-15	-	-
0-10	-	NP	1.35-1.50	6.0-20	0.05-0.07	4.5-7.8	-	-	3-10	-	-
10-60	-	NP	1.40-1.65	6.0-20	0.05-0.10	4.5-8.4	-	-	1-4	-	-

DEPTH (IN.)	ORGANIC MATTER (PCT)	SHRINK-SWELL POTENTIAL	EROSION FACTORS K	T	WIND EROD. GROUP	WIND EROD. INDEX	CORROSIVITY STEEL	CONCRETE
0-10	2-4	LOW	.17	5	2	134	LOW	LOW
0-10	2-4	LOW	.24	5	3	86		
0-10	1-4	LOW	.15	5	1	220		
10-60	0-.5	LOW	.17					

FLOODING FREQUENCY	DURATION	MONTHS	HIGH WATER TABLE DEPTH (FT)	KIND	MONTHS	CEMENTED PAN DEPTH (IN)	HARDNESS	BEDROCK DEPTH (IN)	HARDNESS	SUBSIDENCE INIT. (IN)	TOTAL (IN)	HYD GRP	POTENTIAL FROST ACTION
COMMON	LONG	NOV-MAY	1.0-2.0	APPARENT	NOV-MAY	-		>60		-		B	MODERATE

SANITARY FACILITIES

SEPTIC TANK ABSORPTION FIELDS	SEVERE-FLOODING,WETNESS,POOR FILTER
SEWAGE LAGOON AREAS	SEVERE-SEEPAGE,FLOODING,WETNESS
SANITARY LANDFILL (TRENCH)	SEVERE-FLOODING,SEEPAGE,WETNESS
SANITARY LANDFILL (AREA)	SEVERE-FLOODING,SEEPAGE,WETNESS
DAILY COVER FOR LANDFILL	POOR-SEEPAGE,TOO SANDY,WETNESS

BUILDING SITE DEVELOPMENT

SHALLOW EXCAVATIONS	SEVERE-CUTBANKS CAVE,WETNESS
DWELLINGS WITHOUT BASEMENTS	SEVERE-FLOODING,WETNESS
DWELLINGS WITH BASEMENTS	SEVERE-FLOODING,WETNESS
SMALL COMMERCIAL BUILDINGS	SEVERE-FLOODING,WETNESS
LOCAL ROADS AND STREETS	SEVERE-FLOODING
LAWNS LANDSCAPING AND GOLF FAIRWAYS	OCCAS: MODERATE-FLOODING,DROUGHTY,WETNESS FREQ: SEVERE-FLOODING

CONSTRUCTION MATERIAL

ROADFILL	FAIR-WETNESS
SAND	PROBABLE
GRAVEL	IMPROBABLE-TOO SANDY
TOPSOIL	POOR-TOO SANDY

WATER MANAGEMENT

POND RESERVOIR AREA	SEVERE-SEEPAGE
EMBANKMENTS DIKES AND LEVEES	SEVERE-SEEPAGE,PIPING,WETNESS
EXCAVATED PONDS AQUIFER FED	SEVERE-CUTBANKS CAVE
DRAINAGE	0-3%: FLOODING,CUTBANKS CAVE 3+%: FLOODING,SLOPE,CUTBANKS CAVE
IRRIGATION	0-3%: WETNESS,DROUGHTY 3+%: SLOPE,WETNESS,DROUGHTY
TERRACES AND DIVERSIONS	WETNESS,TOO SANDY,SOIL BLOWING
GRASSED WATERWAYS	WETNESS,DROUGHTY

MLRA(S): 97, 98, 99, 111, 95B
REV. LWB, 3-87
TYPIC ARGIAQUOLLS, FINE-LOAMY, MIXED, MESIC

BARRY SERIES

THE BARRY SERIES CONSISTS OF POORLY DRAINED SOILS FORMED IN CALCAREOUS SANDY LOAM GLACIAL TILL ON NEARLY LEVEL PARTS AND IN DEPRESSIONS OF TILL PLAINS AND MORAINES. THE SURFACE LAYER IS VERY DARK GRAY LOAM 11 INCHES THICK. THE SUBSOIL IS GRAY AND GRAYISH BROWN MOTTLED LOAM AND SANDY CLAY LOAM 25 INCHES THICK. THE SUBSTRATUM IS BROWN MOTTLED SANDY LOAM. SLOPES RANGE FROM 0 TO 3 PERCENT. MOST AREAS ARE USED FOR CROPLAND.

ESTIMATED SOIL PROPERTIES (A)

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT >3 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX
0-11	L, SIL	ML, CL, CL-ML	A-4	0-3	90-100	75-100	70-100	55-90	20-30	NP-10
0-11	SL, FSL	SM, SM-SC, ML, CL-ML	A-4, A-2-4, A-1-B	0-3	90-100	75-100	45-85	20-55	<30	NP-10
11-36	L, SCL, SL	SC, CL	A-6, A-2-6	0-3	90-100	75-100	45-95	20-75	25-35	10-15
36-60	SL, FSL, L	SM, SC, ML, CL	A-4, A-2-4, A-1-B	0-3	90-100	75-100	45-95	20-75	<30	NP-10

DEPTH (IN.)	CLAY (PCT)	MOIST BULK DENSITY (G/CM3)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SHRINK-SWELL POTENTIAL	EROSION FACTORS K	T	WIND EROD. GROUP	ORGANIC MATTER (PCT)	CORROSIVITY STEEL	CONCRETE
0-11	8-18	1.60-1.70	0.6-2.0	0.20-0.22	6.1-7.8	-	LOW	.28	5	5	4-7	HIGH	LOW
0-11	5-18	1.60-1.70	2.0-6.0	0.13-0.17	6.1-7.8	-	LOW	.20	5	3	4-7		
11-36	18-25	1.60-1.70	0.6-2.0	0.14-0.19	6.1-7.8	-	LOW	.28					
36-60	5-18	1.60-1.70	2.0-6.0	0.10-0.17	7.4-8.4	-	LOW	.28					

FLOODING FREQUENCY	DURATION	MONTHS	HIGH WATER TABLE DEPTH (FT)	KIND	MONTHS	CEMENTED PAN DEPTH (IN)	HARDNESS	BEDROCK DEPTH (IN)	HARDNESS	SUBSIDENCE INIT. (IN)	TOTAL (IN)	HYD GRP	POTENT'L FROST ACTION
NONE			+1-1.0	APPARENT	NOV-MAY	-		>60		-		B/D	HIGH

SANITARY FACILITIES

SEPTIC TANK ABSORPTION FIELDS	SEVERE-PONDING
SEWAGE LAGOON AREAS	SEVERE-SEEPAGE,PONDING
SANITARY LANDFILL (TRENCH)	SEVERE-SEEPAGE,PONDING
SANITARY LANDFILL (AREA)	SEVERE-SEEPAGE,PONDING
DAILY COVER FOR LANDFILL	POOR-PONDING

BUILDING SITE DEVELOPMENT

SHALLOW EXCAVATIONS	SEVERE-PONDING
DWELLINGS WITHOUT BASEMENTS	SEVERE-PONDING
DWELLINGS WITH BASEMENTS	SEVERE-PONDING
SMALL COMMERCIAL BUILDINGS	SEVERE-PONDING
LOCAL ROADS AND STREETS	SEVERE-PONDING,FROST ACTION
LAWNS, LANDSCAPING AND GOLF FAIRWAYS	SEVERE-PONDING

REGIONAL INTERPRETATIONS

CONSTRUCTION MATERIAL

ROADFILL	POOR-WETNESS
SAND	IMPROBABLE-EXCESS FINES
GRAVEL	IMPROBABLE-EXCESS FINES
TOPSOIL	POOR-SMALL STONES,WETNESS

WATER MANAGEMENT

POND RESERVOIR AREA	SEVERE-SEEPAGE
EMBANKMENTS DIKES AND LEVEES	SEVERE-THIN LAYER,PONDING
EXCAVATED PONDS AQUIFER FED	MODERATE-SLOW REFILL
DRAINAGE	PONDING,FROST ACTION
IRRIGATION	L,SIL: PONDING SL,FSL: PONDING,SOIL BLOWING
TERRACES AND DIVERSIONS	L,SIL: PONDING SL,FSL: PONDING,SOIL BLOWING
GRASSED WATERWAYS	WETNESS

IL0014 SOIL INTERPRETATIONS RECORD

MLRA(S): 95B, 97, 98, 99, 108, 110, 111 BLOUNT SERIES
REV. JWS, 5-88
AERIC OCHRAQUALFS, FINE, ILLITIC, MESIC

THE BLOUNT SERIES CONSISTS OF SOMEWHAT POORLY DRAINED SOILS FORMED IN GLACIAL TILL. THE SURFACE LAYER IS DARK GRAY SILT LOAM 7 INCHES THICK. THE SUBSURFACE LAYER IS GRAYISH BROWN SILT LOAM 3 INCHES THICK. THE SUBSOIL IS LIGHT YELLOWISH BROWN, YELLOWISH BROWN AND LIGHT BROWNISH GRAY SILTY CLAY LOAM AND SILTY CLAY 22 INCHES THICK. THE SUBSTRATUM IS LIGHT YELLOWISH BROWN SILTY CLAY LOAM. SLOPE RANGES FROM 0 TO 7 PERCENT. AREAS ARE USED FOR CROPLAND.

ESTIMATED SOIL PROPERTIES

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT >3 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX
0-10	SIL, L	CL	A-6, A-4	0-5	95-100	95-100	90-100	80-95	25-40	8-20
0-10	SICL	CL	A-6, A-7	0-5	95-100	95-100	90-100	80-95	30-45	15-25
10-25	SICL, SIC, CL	CH, CL	A-7, A-6	0-5	95-100	90-100	80-90	75-85	35-60	15-35
25-32	SICL, CL	CL, CH, ML, MH	A-6, A-7	0-5	95-100	90-100	80-90	70-90	35-55	10-30
32-60	SICL, CL	CL	A-6, A-7	0-10	90-100	90-100	80-100	70-90	30-45	10-25

DEPTH (IN.)	CLAY (PCT)	MOIST BULK DENSITY (G/CM3)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SHRINK-SWELL POTENTIAL	EROSION FACTORS K	T	WIND EROD. GROUP	ORGANIC MATTER (PCT)	CORROSIVITY STEEL	CONCRETE
0-10	22-27	1.35-1.55	0.6-2.0	0.20-0.24	5.1-7.3	-	LOW	.43	3	6	2-3	HIGH	HIGH
0-10	27-30	1.40-1.60	0.2-0.6	0.18-0.22	5.1-7.3	-	MODERATE	.43	3	7	2-3		
10-25	35-50	1.40-1.70	0.06-0.6	0.12-0.19	4.5-6.5	-	MODERATE	.43					
25-32	27-38	1.50-1.70	0.06-0.6	0.12-0.19	6.1-7.8	-	MODERATE	.43					
32-60	27-38	1.60-1.85	0.06-0.6	0.07-0.10	7.4-8.4	-	MODERATE	.43					

FLOODING FREQUENCY	DURATION	MONTHS	HIGH WATER TABLE DEPTH (FT)	KIND	MONTHS	CEMENTED PAN DEPTH (IN)	HARDNESS	BEDROCK DEPTH (IN)	HARDNESS	SUBSIDENCE INIT. (IN)	TOTAL (IN)	HYD GRP	POTENT'L FROST ACTION
NONE			1.0-3.0	PERCHED	JAN-MAY	-		>60		-		C	HIGH

SANITARY FACILITIES

SEPTIC TANK ABSORPTION FIELDS	SEVERE-WETNESS,PERCS SLOWLY
SEWAGE LAGOON AREAS	SEVERE-WETNESS
SANITARY LANDFILL (TRENCH)	SEVERE-WETNESS
SANITARY LANDFILL (AREA)	SEVERE-WETNESS
DAILY COVER FOR LANDFILL	POOR-WETNESS

BUILDING SITE DEVELOPMENT

SHALLOW EXCAVATIONS	SEVERE-WETNESS
DWELLINGS WITHOUT BASEMENTS	SEVERE-WETNESS
DWELLINGS WITH BASEMENTS	SEVERE-WETNESS
SMALL COMMERCIAL BUILDINGS	SEVERE-WETNESS
LOCAL ROADS AND STREETS	SEVERE-LOW STRENGTH,FROST ACTION
LAWNS, LANDSCAPING AND GOLF FAIRWAYS	MODERATE-WETNESS

CONSTRUCTION MATERIAL

ROADFILL	POOR-LOW STRENGTH
SAND	IMPROBABLE-EXCESS FINES
GRAVEL	IMPROBABLE-EXCESS FINES
TOPSOIL	POOR-TOO CLAYEY

WATER MANAGEMENT

POND RESERVOIR AREA	0-3%: SLIGHT 3-7%: MODERATE-SLOPE
EMBANKMENTS DIKES AND LEVEES	MODERATE-PIPING,WETNESS
EXCAVATED PONDS AQUIFER FED	SEVERE-NO WATER
DRAINAGE	0-3%: PERCS SLOWLY,FROST ACTION 3+%: PERCS SLOWLY,FROST ACTION,SLOPE
IRRIGATION	0-3%: WETNESS,PERCS SLOWLY 3+%: SLOPE,WETNESS,PERCS SLOWLY
TERRACES AND DIVERSIONS	ERODES EASILY,WETNESS,PERCS SLOWLY
GRASSED WATERWAYS	WETNESS,ERODES EASILY,ROOTING DEPTH

REGIONAL INTERPRETATIONS

MI0032 **SOIL INTERPRETATIONS RECORD**

MLRA(S): 90, 91, 95A, 95B, 96, 97, 98, 99, 111 BOYER SERIES
REV. LWB, 2-89
TYPIC HAPLUDALFS, COARSE-LOAMY, MIXED, MESIC

THE BOYER SERIES CONSISTS OF WELL DRAINED SOILS FORMED IN LOAMY AND SANDY GLACIOFLUVIAL DEPOSITS ON OUTWASH PLAINS, VALLEY TRAINS, DELTAS AND MORAINES. THE SURFACE LAYER IS DARK GRAYISH BROWN LOAMY SAND 7 INCHES THICK. THE SUBSURFACE LAYER IS BROWN LOAMY SAND 5 INCHES THICK. THE SUBSOIL IS YELLOWISH BROWN LOAMY SAND IN UPPER 6 INCHES AND DARK BROWN SANDY LOAM AND SANDY CLAY LOAM IN LOWER 16 INCHES. THE SUBSTRATUM IS GRAYISH BROWN GRAVEL AND COARSE SAND. SLOPES RANGE FROM 0 TO 50 PERCENT. MOST AREAS ARE USED FOR CROPLAND.

ESTIMATED SOIL PROPERTIES (A)

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT >3 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	LIQUID LIMIT	PLAS-TICITY INDEX
0-7	LS, LFS	SM, SP-SM	A-2, A-1	0-5	95-100	75-95	30-80	10-35	<20	NP-4
0-7	SL, FSL	SM, SM-SC	A-2, A-4, A-1	0-5	90-100	75-95	45-85	20-50	<25	NP-7
0-7	L	CL-ML, ML, SM, SM-SC	A-4	0-5	90-100	75-95	65-95	45-75	<25	NP-7
7-18	LS, GR-LS, FSL	SM, SM-SC, ML, CL-ML	A-2, A-4, A-1-B	0-5	85-100	60-95	30-85	10-55	<20	NP-4
18-34	SL, L, GR-SCL	SC, SM-SC, CL, CL-ML	A-2, A-4, A-1-B	0-5	80-100	60-95	35-90	15-75	20-30	5-10
34-60	GR-S, COS, G	SP, SP-SM, GP, GP-GM	A-1, A-2, A-3	0-10	40-95	30-85	20-60	0-10	-	NP

DEPTH (IN.)	CLAY (PCT)	MOIST BULK DENSITY (G/CM3)	PERMEA-BILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SHRINK-SWELL POTENTIAL	EROSION FACTORS K	T	WIND EROD. GROUP	ORGANIC MATTER (PCT)	CORROSIVITY STEEL	CONCRETE
0-7	0-10	1.35-1.60	6.0-20	0.08-0.12	5.6-7.3	-	LOW	.17	4	2	.5-3	LOW	MODERATE
0-7	5-15	1.30-1.60	2.0-6.0	0.11-0.15	5.6-7.3	-	LOW	.24	4	3	.5-3		
0-7	7-15	1.30-1.60	2.0-6.0	0.15-0.18	5.6-7.3	-	LOW	.32	4	5	.5-3		
7-18	2-15	1.30-1.60	2.0-6.0	0.08-0.16	5.6-7.3	-	LOW	.17					
18-34	10-18	1.35-1.60	2.0-6.0	0.11-0.13	5.6-7.8	-	LOW	.24					
34-60	0-10	1.40-1.55	>20	0.02-0.04	7.4-8.4	-	LOW	.10					

FLOODING FREQUENCY	DURATION	MONTHS	HIGH WATER TABLE DEPTH (FT)	KIND	MONTHS	CEMENTED PAN DEPTH (IN)	HARDNESS	BEDROCK DEPTH (IN)	HARDNESS	SUBSIDENCE INIT. (IN)	TOTAL (IN)	HYD GRP	POTENT'L FROST ACTION
NONE			>6.0			-		>60		-		B	MODERATE

SANITARY FACILITIES

SEPTIC TANK ABSORPTION FIELDS	0-15%: SEVERE-POOR FILTER 15+%: SEVERE-POOR FILTER,SLOPE
SEWAGE LAGOON AREAS	0-7%: SEVERE-SEEPAGE 7+%: SEVERE-SEEPAGE,SLOPE
SANITARY LANDFILL (TRENCH)	0-15%: SEVERE-SEEPAGE,TOO SANDY 15+%: SEVERE-SEEPAGE,SLOPE,TOO SANDY
SANITARY LANDFILL (AREA)	0-15%: SEVERE-SEEPAGE 15+%: SEVERE-SEEPAGE,SLOPE
DAILY COVER FOR LANDFILL	POOR-SEEPAGE,TOO SANDY,SMALL STONES

BUILDING SITE DEVELOPMENT

SHALLOW EXCAVATIONS	0-15%: SEVERE-CUTBANKS CAVE 15+%: SEVERE-CUTBANKS CAVE,SLOPE
DWELLINGS WITHOUT BASEMENTS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE
DWELLINGS WITH BASEMENTS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE
SMALL COMMERCIAL BUILDINGS	0-4%: SLIGHT 4-8%: MODERATE-SLOPE 8+%: SEVERE-SLOPE
LOCAL ROADS AND STREETS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE
LAWNS, LANDSCAPING AND GOLF FAIRWAYS	0-8%: MODERATE-DROUGHTY 8-15%: MODERATE-DROUGHTY,SLOPE 15+%: SEVERE-SLOPE

REGIONAL INTERPRETATIONS

CONSTRUCTION MATERIAL

ROADFILL	0-15%: GOOD 15-25%: FAIR-SLOPE 25+%: POOR-SLOPE
SAND	PROBABLE
GRAVEL	PROBABLE
TOPSOIL	0-15%: POOR-SMALL STONES,AREA RECLAIM 15+%: POOR-SMALL STONES,AREA RECLAIM,SLOPE

WATER MANAGEMENT

POND RESERVOIR AREA	0-8%: SEVERE-SEEPAGE 8+%: SEVERE-SEEPAGE,SLOPE
EMBANKMENTS DIKES AND LEVEES	SEVERE-SEEPAGE
EXCAVATED PONDS AQUIFER FED	SEVERE-NO WATER
DRAINAGE	DEEP TO WATER
IRRIGATION	0-3% SL,FSL,L: DROUGHTY 3+% SL,FSL,L: SLOPE,DROUGHTY 0-3% LS,LFS: DROUGHTY,FAST INTAKE 3+% LS,LFS: SLOPE,DROUGHTY,FAST INTAKE
TERRACES AND DIVERSIONS	0-8% L: TOO SANDY 8+% L: SLOPE,TOO SANDY 0-8% LS,LFS,SL,FSL: TOO SANDY,SOIL BLOWING 8+% LS,LFS,SL,FSL: SLOPE,TOO SANDY, SOIL BLOWING
GRASSED WATERWAYS	0-8%: DROUGHTY 8+%: SLOPE,DROUGHTY

MI0025

SOIL INTERPRETATIONS RECORD

MLRA(S): 97, 98, 99, 104, 105, 108, 111 — BRADY SERIES

REV. LWB, 1-89

AQUOLLIC HAPLUDALFS, COARSE-LOAMY, MIXED, MESIC

THE BRADY SERIES CONSISTS OF SOMEWHAT POORLY DRAINED SOILS FORMED IN SANDY GLACIOFLUVIAL DEPOSITS ON OUTWASH PLAINS, VALLEY TRAINS AND LAKE PLAINS. THE SURFACE LAYER IS VERY DARK GRAYISH BROWN SANDY LOAM 9 INCHES THICK. THE SUBSURFACE LAYER IS GRAYISH BROWN SANDY LOAM 4 INCHES THICK. THE MOTTLED SUBSOIL IS BROWN SANDY LOAM IN UPPER 10 INCHES, DARK YELLOWISH BROWN SANDY LOAM IN NEXT 14 INCHES AND DARK BROWN LOAMY SAND IN LOWER 19 INCHES. THE SUBSTRATUM IS BROWN MOTTLED GRAVELLY COARSE SAND. SLOPES RANGE FROM 0 TO 6 PERCENT. CROPLAND IS THE MAIN USE.

ESTIMATED SOIL PROPERTIES (A)

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT >3 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX
0-9	SL, FSL	SM, SM-SC, ML, CL-ML	A-2, A-4, A-1	0-5	95-100	75-100	45-85	20-55	<25	NP-7
0-9	L, SIL	ML, CL-ML, SM, SM-SC	A-4	0-5	95-100	75-100	65-95	45-85	<25	NP-7
0-9	LS, LFS	SM, SM-SC, SP-SM	A-1, A-2	0-5	95-100	75-100	35-80	10-35	<25	NP-7
9-37	SL, SCL, GR-SL	SM, SC, ML, CL	A-2, A-4, A-6, A-1	0-5	85-100	60-100	35-90	20-55	15-35	NP-15
37-56	LS, SL	SM, SC, SP-SM, SM-SC	A-2, A-4, A-1	0-5	95-100	75-100	35-70	10-40	<30	NP-10
56-60	GR-S, COS, G	SP, SP-SM, GP, GP-GM	A-1, A-3, A-2-4	0-5	40-95	30-85	20-60	0-10	-	NP

DEPTH (IN.)	CLAY (PCT)	MOIST BULK DENSITY (G/CM3)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SHRINK-SWELL POTENTIAL	EROSION FACTORS K	T	WIND EROD. GROUP	ORGANIC MATTER (PCT)	CORROSIVITY STEEL	CONCRETE
0-9	2-15	1.35-1.55	2.0-6.0	0.12-0.18	5.1-7.3	-	LOW	.20	5	3	2-4	LOW	MODERATE
0-9	7-15	1.35-1.55	2.0-6.0	0.20-0.22	5.1-7.3	-	LOW	.28	5	5	2-4		
0-9	2-15	1.35-1.55	6.0-20	0.08-0.12	5.1-7.3	-	LOW	.17	5	2	2-4		
9-37	5-22	1.35-1.55	2.0-6.0	0.12-0.17	5.1-6.5	-	LOW	.24					
37-56	5-20	1.35-1.50	2.0-6.0	0.08-0.13	5.1-7.3	-	LOW	.20					
56-60	0-10	1.40-1.50	>20	0.02-0.04	6.6-8.4	-	LOW	.10					

FLOODING FREQUENCY	FLOODING DURATION	FLOODING MONTHS	HIGH WATER TABLE DEPTH (FT)	HIGH WATER TABLE KIND	HIGH WATER TABLE MONTHS	CEMENTED PAN DEPTH (IN)	CEMENTED PAN HARDNESS	BEDROCK DEPTH (IN)	BEDROCK HARDNESS	SUBSIDENCE INIT. (IN)	SUBSIDENCE TOTAL (IN)	HYD GRP	POTENT'L FROST ACTION
NONE			1.0-3.0	APPARENT	NOV-MAY	-		>60		-		B	HIGH

SANITARY FACILITIES

SEPTIC TANK ABSORPTION FIELDS	SEVERE-WETNESS
SEWAGE LAGOON AREAS	SEVERE-SEEPAGE,WETNESS
SANITARY LANDFILL (TRENCH)	SEVERE-SEEPAGE,WETNESS
SANITARY LANDFILL (AREA)	SEVERE-SEEPAGE,WETNESS
DAILY COVER FOR LANDFILL	POOR-WETNESS,THIN LAYER

BUILDING SITE DEVELOPMENT

SHALLOW EXCAVATIONS	SEVERE-CUTBANKS CAVE,WETNESS
DWELLINGS WITHOUT BASEMENTS	SEVERE-WETNESS
DWELLINGS WITH BASEMENTS	SEVERE-WETNESS
SMALL COMMERCIAL BUILDINGS	SEVERE-WETNESS
LOCAL ROADS AND STREETS	SEVERE-FROST ACTION
LAWNS, LANDSCAPING AND GOLF FAIRWAYS	MODERATE-WETNESS

REGIONAL INTERPRETATIONS

CONSTRUCTION MATERIAL

ROADFILL	FAIR-WETNESS
SAND	PROBABLE
GRAVEL	PROBABLE
TOPSOIL	POOR-SMALL STONES

WATER MANAGEMENT

POND RESERVOIR AREA	SEVERE-SEEPAGE
EMBANKMENTS DIKES AND LEVEES	SEVERE-PIPING,WETNESS
EXCAVATED PONDS AQUIFER FED	SEVERE-CUTBANKS CAVE
DRAINAGE	0-3%: FROST ACTION 3+%: FROST ACTION,SLOPE
IRRIGATION	0-3% SL,FSL,L,SIL: WETNESS 3+% SL,FSL,L,SIL: SLOPE,WETNESS 0-3% LS,LFS: WETNESS,FAST INTAKE 3+% LS,LFS: SLOPE,WETNESS,FAST INTAKE
TERRACES AND DIVERSIONS	L,SIL: WETNESS SL,FSL,LS,LFS: WETNESS,SOIL BLOWING
GRASSED WATERWAYS	WETNESS

MI0060 SOIL INTERPRETATIONS RECORD

MLRA(S): 97, 98, 99, 111
REV. LWB, 11-87
AQUIC HAPLUDALFS, COARSE-LOAMY, MIXED, MESIC

BRONSON SERIES

THE BRONSON SERIES CONSISTS OF MODERATELY WELL DRAINED SOILS FORMED IN LOAMY AND SANDY GLACIOFLUVIAL DEPOSITS ON OUTWASH PLAINS, VALLEY TRAINS AND MORAINES. THE SURFACE LAYER IS VERY DARK GRAYISH BROWN SANDY LOAM 9 INCHES THICK. THE SUBSURFACE LAYER IS YELLOWISH BROWN SANDY LOAM 11 INCHES THICK. THE SUBSOIL IS STRONG BROWN SANDY LOAM IN UPPER 9 INCHES, STRONG BROWN MOTTLED SANDY CLAY LOAM IN NEXT 14 INCHES, AND YELLOWISH BROWN MOTTLED LOAMY SAND IN LOWER 13 INCHES. THE SUBSTRATUM IS PALE BROWN SAND. SLOPES RANGE FROM 0 TO 7 PERCENT. MOST AREAS ARE USED FOR CROPLAND.

ESTIMATED SOIL PROPERTIES

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT >3 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	LIQUID LIMIT	PLAS-TICITY INDEX
0-20	SL	SM, SM-SC	A-2, A-4	0-5	95-100	90-100	55-70	25-40	<25	NP-7
0-20	LS	SM, SP-SM, SM-SC	A-2, A-1	0-5	95-100	90-100	45-75	10-30	<25	NP-7
20-43	SL, SCL, GR-SL	SC, SM-SC	A-2, A-4, A-6, A-1	0-5	80-95	60-90	35-85	20-50	20-30	4-11
43-56	LS, GR-LS	SM, SP-SM	A-2, A-1	0-5	80-95	60-90	30-70	10-25	<20	NP-4
56-60	S, GR-S, GRV-S	SP, GP, SP-SM, GP-GM	A-1, A-2, A-3	0-10	40-90	35-85	20-60	0-10	-	NP

DEPTH (IN.)	CLAY (PCT)	MOIST BULK DENSITY (G/CM3)	PERMEA-BILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SHRINK-SWELL POTENTIAL	EROSION FACTORS K	T	WIND EROD. GROUP	ORGANIC MATTER (PCT)	CORROSIVITY STEEL	CONCRETE
0-20	2-15	1.30-1.60	2.0-6.0	0.13-0.15	5.1-7.3	-	LOW	.24	4	3	1-3	LOW	MODERATE
0-20	2-12	1.30-1.60	6.0-20	0.10-0.12	5.1-7.3	-	LOW	.17	4	2	.5-3		
20-43	10-20	1.35-1.60	2.0-6.0	0.12-0.18	5.1-7.3	-	LOW	.24					
43-56	0-10	1.35-1.60	6.0-20	0.06-0.08	5.1-7.3	-	LOW	.17					
56-60	0-5	1.50-1.65	6.0-20	0.02-0.04	7.4-8.4	-	LOW	.10					

FLOODING FREQUENCY	DURATION	MONTHS	HIGH WATER TABLE DEPTH (FT)	KIND	MONTHS	CEMENTED PAN DEPTH (IN)	HARDNESS	BEDROCK DEPTH (IN)	HARDNESS	SUBSIDENCE INIT. (IN)	TOTAL (IN)	HYD GRP	POTENT'L FROST ACTION
NONE			2.0-3.5	APPARENT	NOV-MAY	-		>60		-		B	HIGH

SANITARY FACILITIES

SEPTIC TANK ABSORPTION FIELDS	SEVERE-WETNESS
SEWAGE LAGOON AREAS	SEVERE-SEEPAGE,WETNESS
SANITARY LANDFILL (TRENCH)	SEVERE-SEEPAGE,WETNESS
SANITARY LANDFILL (AREA)	SEVERE-SEEPAGE,WETNESS
DAILY COVER FOR LANDFILL	POOR-THIN LAYER

CONSTRUCTION MATERIAL

ROADFILL	FAIR-WETNESS
SAND	PROBABLE
GRAVEL	PROBABLE
TOPSOIL	POOR-SMALL STONES,AREA RECLAIM

BUILDING SITE DEVELOPMENT

SHALLOW EXCAVATIONS	SEVERE-CUTBANKS CAVE,WETNESS
DWELLINGS WITHOUT BASEMENTS	MODERATE-WETNESS
DWELLINGS WITH BASEMENTS	SEVERE-WETNESS
SMALL COMMERCIAL BUILDINGS	0-4%: MODERATE-WETNESS 4-7%: MODERATE-WETNESS,SLOPE
LOCAL ROADS AND STREETS	SEVERE-FROST ACTION
LAWNS, LANDSCAPING AND GOLF FAIRWAYS	SLIGHT

WATER MANAGEMENT

POND RESERVOIR AREA	SEVERE-SEEPAGE
EMBANKMENTS DIKES AND LEVEES	SEVERE-THIN LAYER
EXCAVATED PONDS AQUIFER FED	SEVERE-CUTBANKS CAVE
DRAINAGE	0-3%: FROST ACTION,CUTBANKS CAVE 3+%: FROST ACTION,SLOPE,CUTBANKS CAVE
IRRIGATION	0-3% SL: WETNESS,SOIL BLOWING 3+% SL: SLOPE,WETNESS,SOIL BLOWING 0-3% LS: WETNESS,FAST INTAKE,SOIL BLOWING 3+% LS: SLOPE,WETNESS,FAST INTAKE
TERRACES AND DIVERSIONS	WETNESS,SOIL BLOWING
GRASSED WATERWAYS	FAVORABLE

REGIONAL INTERPRETATIONS

MLRA(S): 91, 97, 98, 95A, 95B
REV. DEJ,FLA, 5-88
ALFIC UDIPSAMMENTS, MIXED, MESIC

COLOMA SERIES

THE COLOMA SERIES CONSISTS OF EXCESSIVELY DRAINED SOILS FORMED IN SANDY DRIFT ON UPLANDS. THE SURFACE LAYER IS VERY DARK BROWN LOAMY SAND 4 INCHES THICK. THE SUBSURFACE LAYER IS DARK BROWN AND STRONG BROWN SAND 35 INCHES THICK. THE NEXT LAYER IS LIGHT BROWN SAND WITH THIN STRATA OF BROWN LOAMY SAND. SLOPES RANGE FROM 0 TO 45 PERCENT. AREAS ARE USED FOR WOODLAND, AND PASTURELAND.

ESTIMATED SOIL PROPERTIES (A)

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT >3 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	LIQUID LIMIT	PLAS-TICITY INDEX
0-4	LS	SM	A-2, A-4	0-8	75-100	75-100	50-90	15-50	-	NP
0-4	S	SP, SM, SP-SM	A-2, A-3	0-8	75-100	75-100	50-70	2-15	-	NP
4-39	S, LS	SP, SM, SP-SM	A-2, A-3	0-8	75-100	75-100	50-100	2-30	-	NP
39-60	SR-S-SL	SP, SM, SP-SM	A-2, A-3, A-4	0-8	75-100	75-100	50-100	2-40	-	NP

DEPTH (IN.)	CLAY (PCT)	MOIST BULK DENSITY (G/CM3)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SHRINK-SWELL POTENTIAL	EROSION FACTORS K	T	WIND EROD. GROUP	ORGANIC MATTER (PCT)	CORROSIVITY STEEL	CONCRETE
0-4	2-10	1.35-1.65	6.0-20	0.08-0.12	4.5-7.3	-	LOW	.17	5	2	<1	LOW	MODERATE
0-4	0-10	1.35-1.65	6.0-20	0.05-0.09	4.5-7.3	-	LOW	.15	5	1	<1		
4-39	0-10	1.35-1.65	6.0-20	0.05-0.12	4.5-6.5	-	LOW	.15					
39-60	2-12	1.50-1.65	6.0-20	0.03-0.08	4.5-6.0	-	LOW	.15					

FLOODING FREQUENCY	DURATION	MONTHS	HIGH WATER TABLE DEPTH (FT)	KIND	MONTHS	CEMENTED PAN DEPTH (IN)	HARDNESS	BEDROCK DEPTH (IN)	HARDNESS	SUBSIDENCE INIT. (IN)	TOTAL (IN)	HYD GRP	POTENT'L FROST ACTION
NONE			>6.0			-		>60		-		A	LOW

SANITARY FACILITIES

SEPTIC TANK ABSORPTION FIELDS	0-15%: SEVERE-POOR FILTER 15+%: SEVERE-POOR FILTER,SLOPE
SEWAGE LAGOON AREAS	0-7%: SEVERE-SEEPAGE 7+%: SEVERE-SEEPAGE,SLOPE
SANITARY LANDFILL (TRENCH)	0-15%: SEVERE-SEEPAGE,TOO SANDY 15+%: SEVERE-SEEPAGE,SLOPE,TOO SANDY
SANITARY LANDFILL (AREA)	0-15%: SEVERE-SEEPAGE 15+%: SEVERE-SEEPAGE,SLOPE
DAILY COVER FOR LANDFILL	0-15%: POOR-SEEPAGE,TOO SANDY 15+%: POOR-SEEPAGE,TOO SANDY,SLOPE

BUILDING SITE DEVELOPMENT

SHALLOW EXCAVATIONS	0-15%: SEVERE-CUTBANKS CAVE 15+%: SEVERE-CUTBANKS CAVE,SLOPE
DWELLINGS WITHOUT BASEMENTS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE
DWELLINGS WITH BASEMENTS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE
SMALL COMMERCIAL BUILDINGS	0-4%: SLIGHT 4-8%: MODERATE-SLOPE 8+%: SEVERE-SLOPE
LOCAL ROADS AND STREETS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE
LAWNS, LANDSCAPING AND GOLF FAIRWAYS	0-8% LS: MODERATE-LARGE STONES,DROUGHTY 8-15%LS:MODERATE-LARGE STONES,DROUGHTY,SLOPE 15+% LS: SEVERE-SLOPE 0-15% S: SEVERE-DROUGHTY 15+% S: SEVERE-DROUGHTY,SLOPE

REGIONAL INTERPRETATIONS

CONSTRUCTION MATERIAL

ROADFILL	0-15%: GOOD 15-25%: FAIR-SLOPE 25+%: POOR-SLOPE
SAND	PROBABLE
GRAVEL	IMPROBABLE-TOO SANDY
TOPSOIL	0-15%: POOR-TOO SANDY,SMALL STONES 15+%: POOR-TOO SANDY,SMALL STONES,SLOPE

WATER MANAGEMENT

POND RESERVOIR AREA	0-8%: SEVERE-SEEPAGE 8+%: SEVERE-SEEPAGE,SLOPE
EMBANKMENTS DIKES AND LEVEES	SEVERE-SEEPAGE,PIPING
EXCAVATED PONDS AQUIFER FED	SEVERE-NO WATER
DRAINAGE	DEEP TO WATER
IRRIGATION	0-3%: DROUGHTY,FAST INTAKE 3+%: SLOPE,DROUGHTY,FAST INTAKE
TERRACES AND DIVERSIONS	0-8%: TOO SANDY,SOIL BLOWING 8+%: SLOPE,TOO SANDY,SOIL BLOWING
GRASSED WATERWAYS	0-8%: DROUGHTY 8+%: SLOPE,DROUGHTY

MLRA(S): 97, 98, 111
REV. LBD, 12-85
AERIC OCHRAQUALFS, FINE-LOAMY, MIXED, MESIC

'E CROSIER SERIES CONSISTS OF DEEP, SOMEWHAT POORLY DRAINED SOILS FORMED IN GLACIAL TILL ON UPLANDS. THE SURFACE LAYER ◌ DARK GRAYISH BROWN LOAM 8 INCHES THICK. THE SUBSURFACE LAYER IS GRAYISH BROWN LOAM 3 INCHES THICK. THE MOTTLED SUBSOIL IS GRAYISH BROWN AND BROWN CLAY LOAM IN UPPER 19 INCHES AND BROWN LOAM IN LOWER 8 INCHES. THE SUBSTRATUM IS BROWN MOTTLED LOAM. SLOPES RANGE FROM 0 TO 4 PERCENT. CROPLAND IS THE DOMINANT USE.

LANDSCAPE AND CLIMATE PROPERTIES

ANNUAL AIR TEMPERATURE	FROST FREE DAYS	ANNUAL PRECIPITATION	ELEVATION (FT)	DRAINAGE CLASS	SLOPE (PCT)
				SP	0-4

ESTIMATED SOIL PROPERTIES

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT. >10 IN (PCT)	FRACT. > 3 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	CLAY (PCT)
0-11	L, SIL	CL	A-4, A-6	0	0	100	95-100	85-95	60-80	7-18
0-11	SL, FSL	SM, SC, SM-SC	A-2, A-4	0	0	100	95-100	60-70	30-40	5-15
11-38	CL, L, SCL	CL	A-6, A-7	0	0	90-95	85-95	75-90	60-70	20-33
38-60	L, SL	CL, ML	A-4, A-6		0-3	85-90	80-90	70-85	50-60	10-20

DEPTH (IN.)	LIQUID LIMIT	PLASTICITY INDEX	MOIST BULK DENSITY (G/CM3)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SAR	CEC (ME/100G)	CACO3 (PCT)	GYPSUM (PCT)
0-11	22-33	8-15	1.30-1.45	0.6-2.0	0.20-0.22	5.6-7.3	-				
0-11	20-30	3-10	1.35-1.50	0.6-2.0	0.13-0.15	5.6-7.3	-				
11-38	33-47	15-26	1.40-1.60	0.2-0.6	0.15-0.19	5.1-7.3	-				
38-60	25-35	2-12	1.40-1.60	0.2-0.6	0.10-0.19	6.1-8.4	-				

DEPTH (IN.)	ORGANIC MATTER (PCT)	SHRINK-SWELL POTENTIAL	EROSION FACTORS K	T	WIND EROD. GROUP	WIND EROD. INDEX	CORROSIVITY STEEL	CONCRETE
0-11	1-3	LOW	.32	5	5	56	HIGH	LOW
0-11	1-3	LOW	.24	5	3	86		
11-38		MODERATE	.32					
38-60		LOW	.32					

FLOODING FREQUENCY	DURATION	MONTHS	HIGH WATER TABLE DEPTH (FT)	KIND	MONTHS	CEMENTED PAN DEPTH (IN)	HARDNESS	BEDROCK DEPTH (IN)	HARDNESS	SUBSIDENCE INIT. (IN)	TOTAL (IN)	HYD GRP	POTENT'L FROST ACTION
NONE			1.0-3.0	APPARENT	JAN-APR	-		>60		-		C	HIGH

SANITARY FACILITIES (A)	
SEPTIC TANK ABSORPTION FIELDS	SEVERE-PERCS SLOWLY,WETNESS
SEWAGE LAGOON AREAS	SEVERE-WETNESS
SANITARY LANDFILL (TRENCH)	SEVERE-WETNESS
SANITARY LANDFILL (AREA)	SEVERE-WETNESS
DAILY COVER FOR LANDFILL	POOR-WETNESS

BUILDING SITE DEVELOPMENT	
SHALLOW EXCAVATIONS	SEVERE-WETNESS
DWELLINGS WITHOUT BASEMENTS	SEVERE-WETNESS
DWELLINGS WITH BASEMENTS	SEVERE-WETNESS
SMALL COMMERCIAL BUILDINGS	SEVERE-WETNESS
LOCAL ROADS AND STREETS	SEVERE-FROST ACTION,LOW STRENGTH
LAWNS, LANDSCAPING AND GOLF FAIRWAYS	MODERATE-WETNESS

CONSTRUCTION MATERIAL	
ROADFILL	FAIR-WETNESS
SAND	IMPROBABLE-EXCESS FINES
GRAVEL	IMPROBABLE-EXCESS FINES
TOPSOIL	FAIR-SMALL STONES

WATER MANAGEMENT	
POND RESERVOIR AREA	0-3%: SLIGHT 3-4%: MODERATE-SLOPE
EMBANKMENTS DIKES AND LEVEES	SEVERE-THIN LAYER,WETNESS
EXCAVATED PONDS AQUIFER FED	SEVERE-SLOW REFILL
DRAINAGE	0-3%: FROST ACTION 3+%: FROST ACTION,SLOPE
IRRIGATION	0-3% L,SIL: WETNESS 3+% L,SIL: SLOPE,WETNESS 0-3% SL,FSL: WETNESS,SOIL BLOWING 3+% SL,FSL: SLOPE,WETNESS,SOIL BLOWING
TERRACES AND DIVERSIONS	L,SIL: WETNESS SL,FSL: WETNESS,SOIL BLOWING
GRASSED WATERWAYS	WETNESS

MLRA(S): 104, 95B, 97, 98, 105 DOWAGIAC SERIES
REV. FRA,GHE, 3-88
MOLLIC HAPLUDALFS, FINE-LOAMY, MIXED, MESIC

THE DOWAGIAC SERIES CONSISTS OF WELL DRAINED SOILS FORMED IN LOAMY AND SANDY DEPOSITS ON OUTWASH PLAINS, TERRACES AND VALLEY TRAINS. THE SURFACE LAYER IS VERY DARK BROWN LOAM 9 INCHES THICK. THE SUBSURFACE LAYER IS DARK GRAYISH BROWN LOAM 2 INCHES THICK. THE SUBSOIL IS DARK BROWN LOAM IN UPPER 5 INCHES, DARK YELLOWISH BROWN CLAY LOAM IN NEXT 13 INCHES, DARK YELLOWISH BROWN SANDY LOAM IN NEXT 9 INCHES AND YELLOWISH BROWN SAND IN LOWER 12 INCHES. THE SUBSTRATUM IS BROWN SAND. SLOPES RANGE FROM 0 TO 18%. MOST AREAS ARE USED FOR CROPLAND.

ESTIMATED SOIL PROPERTIES (A)

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT >3 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX
0-11	L, SIL	ML, CL-ML, CL	A-4	0	95-100	95-100	80-100	60-90	<30	2-10
0-11	SL	SM, SM-SC, SC	A-2-4	0	95-100	95-100	60-70	15-35	<20	2-10
11-29	CL, SL, L	CL, SC	A-6, A-4	0	95-100	70-95	65-90	40-75	25-40	9-20
29-38	SL, COSL, GR-COSL	SM, SM-SC, SC	A-2-4, A-1-B	0	80-100	60-85	40-60	15-30	<25	2-9
38-60	S, LCOS, GR-S	SP, SP-SM, GP, GP-GM	A-1, A-3, A-2-4	0-10	50-90	25-90	10-55	0-10	-	NP

DEPTH (IN.)	CLAY (PCT)	MOIST BULK DENSITY (G/CM3)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SHRINK-SWELL POTENTIAL	EROSION FACTORS K	T	WIND EROD. GROUP	ORGANIC MATTER (PCT)	CORROSIVITY STEEL	CONCRETE
0-11	7-20	1.30-1.60	0.6-2.0	0.16-0.18	5.6-6.5	-	LOW	.28	4	5	1-3	LOW	MODERATE
0-11	2-20	1.30-1.60	2.0-6.0	0.14-0.16	5.6-6.5	-	LOW	.20	4	3	1-3		
11-29	27-35	1.35-1.70	0.6-2.0	0.13-0.14	5.1-6.5	-	MODERATE	.28					
29-38	5-20	1.35-1.70	2.0-6.0	0.14-0.15	5.1-6.5	-	LOW	.28					
38-60	0-10	1.55-1.65	6.0-20	0.01-0.04	5.6-7.3	-	LOW	.15					

FLOODING FREQUENCY	DURATION	MONTHS	HIGH WATER TABLE DEPTH (FT)	KIND	MONTHS	CEMENTED PAN DEPTH (IN)	HARDNESS	BEDROCK DEPTH (IN)	HARDNESS	SUBSIDENCE INIT. (IN)	TOTAL (IN)	HYD GRP	POTENT'L FROST ACTION
NONE			>6.0			-		>60		-		B	MODERATE

SANITARY FACILITIES

SEPTIC TANK ABSORPTION FIELDS	0-15%: SEVERE-POOR FILTER 15+%: SEVERE-POOR FILTER,SLOPE
SEWAGE LAGOON AREAS	0-7%: SEVERE-SEEPAGE 7+%: SEVERE-SEEPAGE,SLOPE
SANITARY LANDFILL (TRENCH)	0-15%: SEVERE-SEEPAGE,TOO SANDY 15+%: SEVERE-SEEPAGE,SLOPE,TOO SANDY
SANITARY LANDFILL (AREA)	0-15%: SEVERE-SEEPAGE 15+%: SEVERE-SEEPAGE,SLOPE
DAILY COVER FOR LANDFILL	POOR-SEEPAGE,TOO SANDY,SMALL STONES

BUILDING SITE DEVELOPMENT

SHALLOW EXCAVATIONS	0-15%: SEVERE-CUTBANKS CAVE 15+%: SEVERE-CUTBANKS CAVE,SLOPE
DWELLINGS WITHOUT BASEMENTS	0-8%: MODERATE-SHRINK-SWELL 8-15%: MODERATE-SHRINK-SWELL,SLOPE 15+%: SEVERE-SLOPE
DWELLINGS WITH BASEMENTS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE
SMALL COMMERCIAL BUILDINGS	0-4%: MODERATE-SHRINK-SWELL 4-8%: MODERATE-SHRINK-SWELL,SLOPE 8+%: SEVERE-SLOPE
LOCAL ROADS AND STREETS	0-8%: MODERATE-LOW STRENGTH,SHRINK-SWELL 8-15%: MODERATE-LOW STRENGTH,SLOPE, SHRINK-SWELL 15+%: SEVERE-SLOPE
LAWNS, LANDSCAPING AND GOLF FAIRWAYS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE

CONSTRUCTION MATERIAL

ROADFILL	0-15%: GOOD 15-18%: FAIR-SLOPE
SAND	PROBABLE
GRAVEL	PROBABLE
TOPSOIL	0-15%: POOR-AREA RECLAIM,SMALL STONES 15+%: POOR-AREA RECLAIM,SLOPE,SMALL STONES

WATER MANAGEMENT

POND RESERVOIR AREA	0-8%: SEVERE-SEEPAGE 8+%: SEVERE-SEEPAGE,SLOPE
EMBANKMENTS DIKES AND LEVEES	SEVERE-SEEPAGE
EXCAVATED PONDS AQUIFER FED	SEVERE-NO WATER
DRAINAGE	DEEP TO WATER
IRRIGATION	0-3% L,SIL: FAVORABLE 3+% L,SIL: SLOPE 0-3% SL: SOIL BLOWING 3+% SL: SOIL BLOWING,SLOPE
TERRACES AND DIVERSIONS	0-8% L,SIL: TOO SANDY 8+% L,SIL: SLOPE,TOO SANDY 0-8% SL: TOO SANDY,SOIL BLOWING 8+% SL: SLOPE,TOO SANDY,SOIL BLOWING
GRASSED WATERWAYS	0-8%: FAVORABLE 8+%: SLOPE

REGIONAL INTERPRETATIONS

MI0016 SOIL INTERPRETATIONS RECORD EDWARDS SERIES

MLRA(S): 91, 95A, 95B, 98, 99, 101, 108, 111, 97
REV. LUB, 7-89
LIMNIC MEDISAPRISTS, MARLY, EUIC, MESIC

THE EDWARDS SERIES CONSISTS OF VERY POORLY DRAINED SOILS FORMED IN ORGANIC MATERIAL OVER MARL IN DEPRESSIONS WITHIN OUTWASH, LAKE AND TILL PLAINS. THE SURFACE SOIL IS BLACK MUCK 32 INCHES THICK. THE SUBSTRATUM IS LIGHT GRAY MARL. SLOPES ARE 0 TO 2 PERCENT. AREAS ARE USED FOR PASTURELAND, WOODLAND AND CROPLAND.

LANDSCAPE AND CLIMATE PROPERTIES

ANNUAL AIR TEMPERATURE	FROST FREE DAYS	ANNUAL PRECIPITATION	ELEVATION (FT)	DRAINAGE CLASS	SLOPE (PCT)
47-50	120-170	30-36	600-1000	VP	0-2

ESTIMATED SOIL PROPERTIES

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT >10 IN (PCT)	FRACT 3-10 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	CLAY (PCT)
0-32	SP MUCK	PT	A-8	0	0					-
32-60	MARL			0	0	100	95-100	80-90	60-80	3-6

DEPTH (IN.)	LIQUID LIMIT	PLASTICITY INDEX	MOIST BULK DENSITY (G/CM3)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SAR	CEC (ME/100G)	CACO3 (PCT)	GYPSUM (PCT)
0-32			0.30-0.55	0.2-6.0	0.35-0.45	5.2-7.8	-	-	150-230	-	-
32-60						7.4-8.4	-	-	1-10	50-90	-

DEPTH (IN.)	ORGANIC MATTER (PCT)	SHRINK-SWELL POTENTIAL	EROSION FACTORS K	T	WIND EROD. GROUP	WIND EROD. INDEX	CORROSIVITY STEEL	CONCRETE
0-32	55-75		-	4	2	134	HIGH	LOW
32-60	-		-					

FLOODING FREQUENCY	DURATION	MONTHS	HIGH WATER TABLE DEPTH (FT)	KIND	MONTHS	CEMENTED PAN DEPTH (IN)	HARDNESS	BEDROCK DEPTH (IN)	HARDNESS	SUBSIDENCE INIT. (IN)	TOTAL (IN)	HYD GRP	POTENT'L FROST ACTION
NONE			+1-1.0	APPARENT	SEP-JUN	-		>60		4-12	25-30	B/D	HIGH

SANITARY FACILITIES		CONSTRUCTION MATERIAL	
SEPTIC TANK ABSORPTION FIELDS	SEVERE-SUBSIDES,PONDING,PERCS SLOWLY	ROADFILL	POOR-WETNESS,LOW STRENGTH
SEWAGE LAGOON AREAS	SEVERE-PONDING,SEEPAGE,EXCESS HUMUS	SAND	IMPROBABLE-EXCESS HUMUS
SANITARY LANDFILL (TRENCH)	SEVERE-PONDING	GRAVEL	IMPROBABLE-EXCESS HUMUS
SANITARY LANDFILL (AREA)	SEVERE-PONDING,SEEPAGE	TOPSOIL	POOR-WETNESS,EXCESS HUMUS
DAILY COVER FOR LANDFILL	POOR-PONDING,EXCESS HUMUS		

BUILDING SITE DEVELOPMENT		WATER MANAGEMENT	
		POND RESERVOIR AREA	SEVERE-SEEPAGE
SHALLOW EXCAVATIONS	SEVERE-PONDING,EXCESS HUMUS	EMBANKMENTS DIKES AND LEVEES	SEVERE-PONDING,EXCESS HUMUS
DWELLINGS WITHOUT BASEMENTS	SEVERE-SUBSIDES,PONDING,LOW STRENGTH	EXCAVATED PONDS AQUIFER FED	SEVERE-SLOW REFILL
DWELLINGS WITH BASEMENTS	SEVERE-SUBSIDES,PONDING,LOW STRENGTH	DRAINAGE	FROST ACTION,PONDING,SUBSIDES
SMALL COMMERCIAL BUILDINGS	SEVERE-SUBSIDES,PONDING,LOW STRENGTH	IRRIGATION	PONDING,SOIL BLOWING
LOCAL ROADS AND STREETS	SEVERE-SUBSIDES,PONDING,FROST ACTION	TERRACES AND DIVERSIONS	PONDING,SOIL BLOWING
LAWNS LANDSCAPING AND GOLF FAIRWAYS	SEVERE-EXCESS HUMUS,PONDING	GRASSED WATERWAYS	WETNESS

SOIL INTERPRETATIONS RECORD

MLRA(S): 97, 98, 99, 111
REV. GAW, 7-87
TYPIC HAPLUDALFS, COARSE-LOAMY, MIXED, MESIC

ELMDALE SERIES

THE ELMDALE SERIES CONSISTS OF MODERATELY WELL DRAINED SOILS FORMED IN SANDY LOAM GLACIAL TILL ON UPLANDS. THE SURFACE LAYER IS DARK GRAYISH BROWN FINE SANDY LOAM 9 INCHES THICK. THE SUBSOIL IS DARK YELLOWISH BROWN LOAMY FINE SAND AND FINE SANDY LOAM IN UPPER 18 INCHES AND DARK YELLOWISH BROWN MOTTLED FINE SANDY LOAM IN LOWER 23 INCHES. THE SUBSTRATUM IS DARK YELLOWISH BROWN MOTTLED FINE SANDY LOAM. SLOPES RANGE FROM 0 TO 12 PERCENT. CROPLAND IS THE MAIN USE.

ESTIMATED SOIL PROPERTIES (A)

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT >3 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX
0-9	SL, FSL	SM, SM-SC	A-2-4, A-4, A-1-B	0-10	90-100	85-100	45-70	15-40	<25	2-7
0-9	L	ML, CL-ML	A-4	0-5	95-100	90-100	75-95	50-75	18-28	2-7
9-54	SL, FSL, LFS	SM, CL, SC, ML	A-2, A-4, A-6	0-10	90-100	85-100	55-95	25-70	14-30	2-18
54-60	SL, FSL	SM, SM-SC, SC	A-2-4, A-4	0-5	95-100	95-100	50-70	20-40	<25	NP-8

DEPTH (IN.)	CLAY (PCT)	MOIST BULK DENSITY (G/CM3)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SHRINK-SWELL POTENTIAL	EROSION FACTORS K	T	WIND EROD. GROUP	ORGANIC MATTER (PCT)	CORROSIVITY STEEL	CONCRETE
0-9	2-15	1.10-1.55	2.0-6.0	0.12-0.15	5.1-7.3	-	LOW	.24	5	3	1-3	LOW	HIGH
0-9	2-15	1.10-1.65	0.6-2.0	0.17-0.22	5.1-7.3	-	LOW	.32	5	5	1-3		
9-54	10-18	1.20-1.70	0.6-2.0	0.11-0.17	4.5-7.3	-	LOW	.24					
54-60	2-15	1.80-2.00	0.6-2.0	0.10-0.13	6.6-8.4	-	LOW	.24					

FLOODING FREQUENCY	DURATION	MONTHS	HIGH WATER TABLE DEPTH (FT)	KIND	MONTHS	CEMENTED PAN DEPTH (IN)	HARDNESS	BEDROCK DEPTH (IN)	HARDNESS	SUBSIDENCE INIT. (IN)	TOTAL (IN)	HYD GRP	POTENT'L FROST ACTION
NONE			2.0-3.0	APPARENT	NOV-APR	-		>60		-		B	MODERATE

SANITARY FACILITIES

SEPTIC TANK ABSORPTION FIELDS	SEVERE-WETNESS
SEWAGE LAGOON AREAS	0-7%: SEVERE-WETNESS 7+%: SEVERE-SLOPE,WETNESS
SANITARY LANDFILL (TRENCH)	SEVERE-WETNESS
SANITARY LANDFILL (AREA)	SEVERE-WETNESS
DAILY COVER FOR LANDFILL	0-8%: FAIR-TOO SANDY,WETNESS 8-12%: FAIR-TOO SANDY,SLOPE,WETNESS

BUILDING SITE DEVELOPMENT

SHALLOW EXCAVATIONS	SEVERE-CUTBANKS CAVE,WETNESS
DWELLINGS WITHOUT BASEMENTS	0-8%: MODERATE-WETNESS 8-12%: MODERATE-WETNESS,SLOPE
DWELLINGS WITH BASEMENTS	SEVERE-WETNESS
SMALL COMMERCIAL BUILDINGS	0-4%: MODERATE-WETNESS 4-8%: MODERATE-WETNESS,SLOPE 8+%: SEVERE-SLOPE
LOCAL ROADS AND STREETS	0-8%: MODERATE-WETNESS,FROST ACTION 8-12%: MODERATE-WETNESS,SLOPE,FROST ACTION
LAWNS, LANDSCAPING AND GOLF FAIRWAYS	0-8% L: SLIGHT 8-12% L: MODERATE-SLOPE 0-8% SL,FSL: MODERATE-LARGE STONES 8-12% SL,FSL: MODERATE-LARGE STONES,SLOPE

CONSTRUCTION MATERIAL

ROADFILL	FAIR-WETNESS
SAND	IMPROBABLE-EXCESS FINES
GRAVEL	IMPROBABLE-EXCESS FINES
TOPSOIL	0-8%: FAIR-SMALL STONES 8-12%: FAIR-SMALL STONES,SLOPE

WATER MANAGEMENT

POND RESERVOIR AREA	0-3%: MODERATE-SEEPAGE 3-8%: MODERATE-SEEPAGE,SLOPE 8+%: SEVERE-SLOPE
EMBANKMENTS DIKES AND LEVEES	SEVERE-PIPING
EXCAVATED PONDS AQUIFER FED	SEVERE-CUTBANKS CAVE
DRAINAGE	0-3%: CUTBANKS CAVE 3+%: SLOPE,CUTBANKS CAVE
IRRIGATION	0-3% L: WETNESS 3+% L: SLOPE,WETNESS 0-3% SL,FSL: WETNESS,SOIL BLOWING 3+% SL,FSL: SLOPE,WETNESS,SOIL BLOWING
TERRACES AND DIVERSIONS	0-8% L: WETNESS 8+% L: SLOPE,WETNESS 0-8% SL,FSL: WETNESS,SOIL BLOWING 8+% SL,FSL: SLOPE,WETNESS,SOIL BLOWING
GRASSED WATERWAYS	0-8%: FAVORABLE 8+%: SLOPE

REGIONAL INTERPRETATIONS

SOIL INTERPRETATIONS RECORD

MLRA(S): 95B, 97, 98, 99, 108, 110, 111, 115
REV. JDL, 6-87
TYPIC HAPLAQUOLLS, COARSE-LOAMY, MIXED, MESIC

GILFORD SERIES

THE GILFORD SERIES CONSISTS OF DEEP, VERY POORLY AND POORLY DRAINED SOILS FORMED IN SANDY SEDIMENTS ON OUTWASH PLAINS AND LAKE PLAINS. THE SURFACE SOIL IS BLACK SANDY LOAM IN UPPER 11 INCHES AND VERY DARK GRAY SANDY LOAM IN LOWER 3 INCHES. THE MOTTLED SUBSOIL IS GRAY SANDY LOAM IN UPPER 18 INCHES AND GRAY LOAMY SAND IN LOWER 6 INCHES. THE SUBSTRATUM IS GRAY SAND AND COARSE SAND. SLOPES ARE 0 TO 2 PERCENT. MOST AREAS ARE USED FOR CROPLAND.

ESTIMATED SOIL PROPERTIES

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT >3 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	LIQUID LIMIT	PLAS-TICITY INDEX
0-14	FSL, SL	SM, SC, SM-SC	A-4, A-2-4	0	95-100	95-100	60-80	30-45	<25	2-10
0-14	MK-SL, MK-FSL	SC, SM-SC	A-4, A-2-4	0	95-100	95-100	60-80	30-45	20-30	4-10
0-14	L	CL	A-4, A-6	0	95-100	95-100	85-95	60-75	22-33	8-15
14-32	SL, FSL	SM, SC, SM-SC	A-2-4	0	95-100	95-100	55-70	20-35	15-30	NP-8
32-48	LS, S, LFS	SM, SP, SP-SM	A-3, A-1-B, A-2-4	0	95-100	95-100	15-60	3-20	-	NP
48-60	S, COS, LS	SP, SP-SM, SM	A-1-B, A-2-4, A-3	0	95-100	95-100	15-60	3-20	-	NP

DEPTH (IN.)	CLAY (PCT)	MOIST BULK DENSITY (G/CM3)	PERMEA-BILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SHRINK-SWELL POTENTIAL	EROSION FACTORS K	T	WIND EROD. GROUP	ORGANIC MATTER (PCT)	CORROSIVITY STEEL	CONCRETE
0-14	10-20	1.50-1.70	2.0-6.0	0.16-0.18	5.6-7.3	-	LOW	.20	4	3	2-4	HIGH	MODERATE
0-14	10-20	1.50-1.70	2.0-6.0	0.13-0.15	5.6-7.3	-	LOW	.20	4	3	10-20		
0-14	10-20	1.50-1.70	2.0-6.0	0.20-0.22	5.6-7.3	-	LOW	.28	4	5	2-4		
14-32	8-17	1.60-1.80	2.0-6.0	0.12-0.14	5.6-7.3	-	LOW	.20					
32-48	3-12	1.70-1.90	6.0-20	0.05-0.08	6.1-7.3	-	LOW	.15					
48-60	2-10	1.70-1.90	6.0-20	0.05-0.08	6.6-8.4	-	LOW	.15					

FLOODING FREQUENCY	DURATION	MONTHS	HIGH WATER TABLE DEPTH (FT)	KIND	MONTHS	CEMENTED PAN DEPTH (IN)	HARDNESS	BEDROCK DEPTH (IN)	HARDNESS	SUBSIDENCE INIT. (IN)	TOTAL (IN)	HYD GRP	POTENT'L FROST ACTION
NONE			+.5-1.0	APPARENT	DEC-MAY	-		>60		-		B/D	HIGH

SANITARY FACILITIES

SEPTIC TANK ABSORPTION FIELDS	SEVERE-PONDING,POOR FILTER
SEWAGE LAGOON AREAS	SEVERE-SEEPAGE,PONDING
SANITARY LANDFILL (TRENCH)	SEVERE-SEEPAGE,PONDING
SANITARY LANDFILL (AREA)	SEVERE-SEEPAGE,PONDING
DAILY COVER FOR LANDFILL	POOR-PONDING,THIN LAYER

BUILDING SITE DEVELOPMENT

SHALLOW EXCAVATIONS	SEVERE-CUTBANKS CAVE,PONDING
DWELLINGS WITHOUT BASEMENTS	SEVERE-PONDING
DWELLINGS WITH BASEMENTS	SEVERE-PONDING
SMALL COMMERCIAL BUILDINGS	SEVERE-PONDING
LOCAL ROADS AND STREETS	SEVERE-PONDING,FROST ACTION
LAWNS, LANDSCAPING AND GOLF FAIRWAYS	SEVERE-PONDING

CONSTRUCTION MATERIAL

ROADFILL	POOR-WETNESS
SAND	PROBABLE
GRAVEL	IMPROBABLE-TOO SANDY
TOPSOIL	POOR-WETNESS

WATER MANAGEMENT

POND RESERVOIR AREA	SEVERE-SEEPAGE
EMBANKMENTS DIKES AND LEVEES	SEVERE-PIPING,PONDING
EXCAVATED PONDS AQUIFER FED	SEVERE-CUTBANKS CAVE
DRAINAGE	PONDING,FROST ACTION,CUTBANKS CAVE
IRRIGATION	L: PONDING FSL,SL,MK: PONDING,SOIL BLOWING
TERRACES AND DIVERSIONS	L: PONDING,TOO SANDY FSL,SL,MK: PONDING,TOO SANDY,SOIL BLOWING
GRASSED WATERWAYS	WETNESS

REGIONAL INTERPRETATIONS

MLRA(S): 111, 99, 97, 98
REV. LAT, 2-89
AQUIC HAPLUDALFS, FINE, ILLITIC, MESIC

THE GLYNWOOD SERIES CONSISTS OF DEEP, MODERATELY WELL DRAINED SOILS FORMED IN A THIN LOESS DEPOSIT AND THE UNDERLYING GLACIAL TILL ON UPLANDS. THE SURFACE LAYER IS DARK GRAYISH BROWN SILT LOAM 9 INCHES THICK. THE MOTTLED SUBSOIL IS DARK YELLOWISH BROWN SILTY CLAY LOAM IN UPPER 3 INCHES, DARK YELLOWISH BROWN CLAY IN NEXT 11 INCHES AND YELLOWISH BROWN CLAY LOAM IN LOWER 9 INCHES. THE SUBSTRATUM IS YELLOWISH BROWN CLAY LOAM. SLOPES RANGE FROM 0 TO 40 PERCENT. MOST AREAS ARE USED FOR CROPLAND.

LANDSCAPE AND CLIMATE PROPERTIES

ANNUAL AIR TEMPERATURE	FROST FREE DAYS	ANNUAL PRECIPITATION	ELEVATION (FT)	DRAINAGE CLASS	SLOPE (PCT)
				MW	0-40

ESTIMATED SOIL PROPERTIES

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT. >10 IN (PCT)	FRACT. > 3 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	CLAY (PCT)
0-9	SIL, L	CL-ML, CL	A-4, A-6	0	0	95-100	90-100	80-100	55-90	16-27
0-9	SICL, CL	CL	A-6, A-7		0-2	95-100	85-100	75-100	60-95	27-38
0-9	SIC	CH, CL	A-7		0-2	95-100	85-100	75-100	65-95	40-50
9-23	C, CL, SICL	CL, CH	A-7, A-6		0-5	95-100	85-100	75-100	65-95	35-55
23-60	CL, SICL	CL	A-6, A-4		0-5	95-100	80-100	75-95	65-90	27-36

DEPTH (IN.)	LIQUID LIMIT	PLASTICITY INDEX	MOIST BULK DENSITY (G/CM3)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SAR	CEC (ME/100G)	CACO3 (PCT)	GYPSUM (PCT)
0-9	25-40	4-15	1.25-1.50	0.6-2.0	0.20-0.24	5.1-7.3	-				
0-9	25-45	10-22	1.35-1.55	0.2-0.6	0.17-0.23	5.1-7.3	-				
0-9	40-55	15-30	1.35-1.50	0.06-0.2	0.14-0.16	5.1-7.3	-				
9-23	35-55	15-30	1.45-1.70	0.06-0.2	0.11-0.18	4.5-7.8	-				
23-60	25-40	7-18	1.65-1.85	0.06-0.2	0.06-0.10	7.4-8.4	-				

DEPTH (IN.)	ORGANIC MATTER (PCT)	SHRINK-SWELL POTENTIAL	EROSION FACTORS K	T	WIND EROD. GROUP	WIND EROD. INDEX	CORROSIVITY STEEL	CONCRETE
0-9	1-3	LOW	.43	3-2	6	48	HIGH	MODERATE
0-9	1-2	LOW	.43	3-2	7	38		
0-9	1-2	MODERATE	.32	3-2	4	86		
9-23		MODERATE	.32					
23-60		MODERATE	.32					

FLOODING FREQUENCY	DURATION	MONTHS	HIGH WATER TABLE DEPTH (FT)	KIND	MONTHS	CEMENTED PAN DEPTH (IN)	HARDNESS	BEDROCK DEPTH (IN)	HARDNESS	SUBSIDENCE INIT. (IN)	TOTAL (IN)	HYD GRP	POTENT'L FROST ACTION
NONE			2.0-3.5	PERCHED	JAN-APR	-		>60		-		C	HIGH

SANITARY FACILITIES

SEPTIC TANK ABSORPTION FIELDS	0-15%: SEVERE-WETNESS,PERCS SLOWLY 15+%: SEVERE-WETNESS,PERCS SLOWLY,SLOPE
SEWAGE LAGOON AREAS	0-2%: SLIGHT 2-7%: MODERATE-SLOPE 7+%: SEVERE-SLOPE
SANITARY LANDFILL (TRENCH)	0-8%: MODERATE-WETNESS,TOO CLAYEY 8-15%: MODERATE-WETNESS,SLOPE,TOO CLAYEY 15+%: SEVERE-SLOPE
SANITARY LANDFILL (AREA)	0-8%: MODERATE-WETNESS 8-15%: MODERATE-WETNESS,SLOPE 15+%: SEVERE-SLOPE
DAILY COVER FOR LANDFILL	0-8%: FAIR-TOO CLAYEY,WETNESS 8-15%: FAIR-TOO CLAYEY,SLOPE,WETNESS 15+%: POOR-SLOPE

BUILDING SITE DEVELOPMENT

SHALLOW EXCAVATIONS	0-15%: SEVERE-WETNESS 15+%: SEVERE-WETNESS,SLOPE
DWELLINGS WITHOUT BASEMENTS	0-8%: MODERATE-WETNESS,SHRINK-SWELL 8-15%: MODERATE-WETNESS,SHRINK-SWELL,SLOPE 15+%: SEVERE-SLOPE
DWELLINGS WITH BASEMENTS	0-15%: SEVERE-WETNESS 15+%: SEVERE-WETNESS,SLOPE
SMALL COMMERCIAL BUILDINGS	0-4%: MODERATE-WETNESS,SHRINK-SWELL 4-8%: MODERATE-WETNESS,SHRINK-SWELL,SLOPE 8+%: SEVERE-SLOPE
LOCAL ROADS AND STREETS	0-15%: SEVERE-LOW STRENGTH,FROST ACTION 15+%: SEVERE-LOW STRENGTH,SLOPE,FROST ACTION
LAWNS, LANDSCAPING AND GOLF FAIRWAYS	0-8% SIL, L, SICL, CL: SLIGHT 8-15% SIL, L, SICL, CL: MODERATE-SLOPE 15+% SIL, L, SICL, CL: SEVERE-SLOPE 0-15% SIC: SEVERE-TOO CLAYEY 15+% SIC: SEVERE-SLOPE,TOO CLAYEY

CONSTRUCTION MATERIAL

ROADFILL	0-25%: POOR-LOW STRENGTH 25+%: POOR-LOW STRENGTH,SLOPE
SAND	IMPROBABLE-EXCESS FINES
GRAVEL	IMPROBABLE-EXCESS FINES
TOPSOIL	0-15%: POOR-THIN LAYER 15+%: POOR-THIN LAYER,SLOPE

WATER MANAGEMENT

POND RESERVOIR AREA	0-3%: SLIGHT 3-8%: MODERATE-SLOPE 8+%: SEVERE-SLOPE
EMBANKMENTS DIKES AND LEVEES	MODERATE-PIPING,WETNESS
EXCAVATED PONDS AQUIFER FED	SEVERE-NO WATER
DRAINAGE	0-3%: PERCS SLOWLY,FROST ACTION 3+%: PERCS SLOWLY,FROST ACTION,SLOPE
IRRIGATION	0-3% SIL, L, SICL, CL: WETNESS 3+% SIL, L, SICL, CL: SLOPE,WETNESS 0-3% SIC: WETNESS,DROUGHTY 3+% SIC: SLOPE,WETNESS,DROUGHTY
TERRACES AND DIVERSIONS	0-8% SIC: WETNESS 8+% SIC: SLOPE,WETNESS 0-8% SIL, L, SICL, CL: ERODES EASILY,WETNESS 8+% SIL, L, SICL, CL: SLOPE,ERODES EASILY, WETNESS
GRASSED WATERWAYS	0-8% SIC: ROOTING DEPTH 8+% SIC: SLOPE,ROOTING DEPTH 0-8% SIL, L, SICL, CL: ERODES EASILY, ROOTING DEPTH 8+% SIL, L, SICL, CL: SLOPE,ERODES EASILY

MI0029

S O I L   I N T E R P R E T A T I O N S   R E C O R D

MLRA(S): 91, 95A, 95B, 97, 98, 99, 103, 105, 110
REV. LWB, 12-87
TYPIC HAPLAQUOLLS, SANDY, MIXED, MESIC

GRANBY SERIES
MAAT<50

THE GRANBY SERIES, MAAT <50, CONSISTS OF POORLY AND VERY POORLY DRAINED SOILS FORMED IN SANDY GLACIOFLUVIAL DEPOSITS ON OUTWASH PLAINS AND LAKE PLAINS AND IN GLACIAL DRAINAGEWAYS. THE SURFACE LAYER IS BLACK LOAMY SAND 10 INCHES THICK. THE SUBSOIL IS DARK GRAY AND LIGHT BROWNISH GRAY MOTTLED SAND 22 INCHES THICK. THE SUBSTRATUM IS LIGHT GRAY MOTTLED SAND. SLOPES ARE 0 TO 3 PERCENT. AREAS ARE USED FOR CROPLAND. PASTURELAND, HAYLAND AND WOODLAND.

ESTIMATED SOIL PROPERTIES (A)

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT >3 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX
0-10	LS, LFS	SM	A-2	0	100	100	50-80	15-35	-	NP
0-10	FSL, SL	SM, SC, SM-SC	A-2, A-4	0	100	100	60-85	30-50	<30	NP-10
0-10	S, FS	SP-SM, SM	A-3, A-2	0	100	100	50-80	5-35	-	NP
10-32	S, FS, LS	SP-SM, SM	A-3, A-2, A-1	0	100	95-100	45-80	5-35	-	NP
32-60	S, FS, LS	SP-SM, SM	A-3, A-2, A-1	0	100	95-100	45-80	5-35	-	NP

DEPTH (IN.)	CLAY (PCT)	MOIST BULK DENSITY (G/CM3)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SHRINK-SWELL POTENTIAL	EROSION FACTORS K	T	WIND EROD. GROUP	ORGANIC MATTER (PCT)	CORROSIVITY STEEL	CONCRETE
0-10	2-14	1.20-1.50	6.0-20	0.10-0.12	5.6-7.3	-	LOW	.17	5	2	4-10	HIGH	LOW
0-10	8-18	1.20-1.60	2.0-6.0	0.16-0.18	5.6-7.3	-	LOW	.20	5	3	4-6		
0-10	2-10	1.20-1.60	6.0-20	0.07-0.10	5.6-7.3	-	LOW	.15	5	1	4-10		
10-32	0-14	1.45-1.60	6.0-20	0.05-0.12	5.6-7.8	-	LOW	.17					
32-60	0-10	1.45-1.60	6.0-20	0.05-0.09	6.6-8.4	-	LOW	.17					

FLOODING FREQUENCY	DURATION	MONTHS	HIGH WATER TABLE DEPTH (FT)	KIND	MONTHS	CEMENTED PAN DEPTH (IN)	HARDNESS	BEDROCK DEPTH (IN)	HARDNESS	SUBSIDENCE INIT. (IN)	TOTAL (IN)	HYD GRP	POTENTIAL FROST ACTION
NONE			+1-1.0	APPARENT	NOV-JUN	-		>60		-		A/D	MODERATE

SANITARY FACILITIES

SEPTIC TANK ABSORPTION FIELDS	SEVERE-PONDING,POOR FILTER
SEWAGE LAGOON AREAS	SEVERE-SEEPAGE,PONDING
SANITARY LANDFILL (TRENCH)	SEVERE-SEEPAGE,PONDING,TOO SANDY
SANITARY LANDFILL (AREA)	SEVERE-SEEPAGE,PONDING
DAILY COVER FOR LANDFILL	POOR-SEEPAGE,TOO SANDY,PONDING

BUILDING SITE DEVELOPMENT

SHALLOW EXCAVATIONS	SEVERE-CUTBANKS CAVE,PONDING
DWELLINGS WITHOUT BASEMENTS	SEVERE-PONDING
DWELLINGS WITH BASEMENTS	SEVERE-PONDING
SMALL COMMERCIAL BUILDINGS	SEVERE-PONDING
LOCAL ROADS AND STREETS	SEVERE-PONDING
LAWNS, LANDSCAPING AND GOLF FAIRWAYS	SEVERE-PONDING

CONSTRUCTION MATERIAL

ROADFILL	POOR-WETNESS
SAND	PROBABLE
GRAVEL	IMPROBABLE-TOO SANDY
TOPSOIL	POOR-TOO SANDY,WETNESS

WATER MANAGEMENT

POND RESERVOIR AREA	SEVERE-SEEPAGE
EMBANKMENTS DIKES AND LEVEES	SEVERE-SEEPAGE,PIPING,PONDING
EXCAVATED PONDS AQUIFER FED	SEVERE-CUTBANKS CAVE
DRAINAGE	PONDING,CUTBANKS CAVE
IRRIGATION	FSL,SL: PONDING,DROUGHTY,SOIL BLOWING LS,LFS,S,FS: PONDING,DROUGHTY,FAST INTAKE
TERRACES AND DIVERSIONS	PONDING,TOO SANDY,SOIL BLOWING
GRASSED WATERWAYS	WETNESS,DROUGHTY

REGIONAL INTERPRETATIONS

MI0012 SOIL INTERPRETATIONS RECORD

MLRA(S): 97, 98, 111
REV. LWB, 8-87
TYPIC HAPLUDALFS, COARSE-LOAMY, MIXED, MESIC

HILLSDALE SERIES

THE HILLSDALE SERIES CONSISTS OF WELL DRAINED SOILS FORMED IN LOAMY GLACIAL TILL ON TILL PLAINS AND MORAINES. THE SURFACE LAYER IS DARK GRAYISH BROWN SANDY LOAM 10 INCHES THICK. THE SUBSURFACE LAYER IS BROWN SANDY LOAM 5 INCHES THICK. THE SUBSOIL IS DARK BROWN AND DARK YELLOWISH BROWN SANDY LOAM 48 INCHES THICK. THE SUBSTRATUM IS YELLOWISH BROWN SANDY LOAM. SLOPES RANGE FROM 0 TO 40 PERCENT. AREAS ARE USED FOR CROPLAND, PASTURE AND WOODLAND.

ESTIMATED SOIL PROPERTIES (A)

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT >3 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX
0-15	SL, FSL	SM, SC, ML, CL	A-2-4, A-4, A-1-B	0-5	90-100	75-100	45-85	20-55	<25	2-10
0-15	LS	SM, SM-SC	A-2-4, A-1-B	0-5	90-100	75-100	45-75	15-30	<25	NP-5
0-15	L	ML, CL, SM, SC	A-4	0-5	90-100	75-100	65-90	45-70	<25	2-10
15-35	SL, SCL, L	SM-SC, SC, CL-ML, CL	A-2-4, A-4	0-5	90-100	75-100	55-85	30-70	20-30	4-10
35-63	SL, LS	SM, SM-SC, SC, SP-SM	A-2-4, A-1-B	0-5	90-100	75-100	35-70	10-30	<25	2-10
63-70	SL, LS	SM, SM-SC, SC, SP-SM	A-2-4, A-4, A-1-B	0-5	90-100	75-100	40-75	5-40	<25	2-10

DEPTH (IN.)	CLAY (PCT)	MOIST BULK DENSITY (G/CM3)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SHRINK-SWELL POTENTIAL	EROSION FACTORS K	T	WIND EROD. GROUP	ORGANIC MATTER (PCT)	CORROSIVITY STEEL	CONCRETE
0-15	2-15	1.30-1.60	2.0-6.0	0.13-0.18	5.1-7.3	-	LOW	.24	5	3	1-3	LOW	HIGH
0-15	2-12	1.30-1.60	6.0-20	0.10-0.12	5.1-7.3	-	LOW	.17	5	2	1-3		
0-15	7-15	1.30-1.60	0.6-2.0	0.18-0.20	5.1-7.3	-	LOW	.32	5	5	1-3		
15-35	10-18	1.40-1.70	0.6-2.0	0.12-0.18	4.5-6.5	-	LOW	.24					
35-63	5-15	1.60-1.75	0.6-6.0	0.08-0.13	5.1-6.5	-	LOW	.24					
63-70	5-15	1.60-1.80	0.6-6.0	0.08-0.13	7.9-8.4	-	LOW	.24					

FLOODING FREQUENCY	DURATION	MONTHS	HIGH WATER TABLE DEPTH (FT)	KIND	MONTHS	CEMENTED PAN DEPTH (IN)	HARDNESS	BEDROCK DEPTH (IN)	HARDNESS	SUBSIDENCE INIT. (IN)	TOTAL (IN)	HYD GRP	POTENT'L FROST ACTION
NONE			>6.0			-		>60		-		B	MODERATE

SANITARY FACILITIES

SEPTIC TANK ABSORPTION FIELDS	0-8%: MODERATE-PERCS SLOWLY 8-15%: MODERATE-PERCS SLOWLY,SLOPE 15+%: SEVERE-SLOPE
SEWAGE LAGOON AREAS	0-7%: SEVERE-SEEPAGE 7+%: SEVERE-SEEPAGE,SLOPE
SANITARY LANDFILL (TRENCH)	0-15%: SEVERE-SEEPAGE 15+%: SEVERE-SEEPAGE,SLOPE
SANITARY LANDFILL (AREA)	0-15%: SEVERE-SEEPAGE 15+%: SEVERE-SEEPAGE,SLOPE
DAILY COVER FOR LANDFILL	0-8%: FAIR-TOO SANDY,SMALL STONES 8-15%: FAIR-TOO SANDY,SMALL STONES,SLOPE 15+%: POOR-SLOPE

BUILDING SITE DEVELOPMENT

SHALLOW EXCAVATIONS	0-15%: SEVERE-CUTBANKS CAVE 15+%: SEVERE-CUTBANKS CAVE,SLOPE
DWELLINGS WITHOUT BASEMENTS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE
DWELLINGS WITH BASEMENTS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE
SMALL COMMERCIAL BUILDINGS	0-4%: SLIGHT 4-8%: MODERATE-SLOPE 8+%: SEVERE-SLOPE
LOCAL ROADS AND STREETS	0-8%: MODERATE-FROST ACTION 8-15%: MODERATE-SLOPE,FROST ACTION 15+%: SEVERE-SLOPE
LAWNS, LANDSCAPING AND GOLF FAIRWAYS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE

REGIONAL INTERPRETATIONS

CONSTRUCTION MATERIAL

ROADFILL	0-15%: GOOD 15-25%: FAIR-SLOPE 25+%: POOR-SLOPE
SAND	IMPROBABLE-EXCESS FINES
GRAVEL	IMPROBABLE-EXCESS FINES
TOPSOIL	0-15%: POOR-SMALL STONES 15+%: POOR-SMALL STONES,SLOPE

WATER MANAGEMENT

POND RESERVOIR AREA	0-8%: SEVERE-SEEPAGE 8+%: SEVERE-SEEPAGE,SLOPE
EMBANKMENTS DIKES AND LEVEES	SEVERE-SEEPAGE,PIPING
EXCAVATED PONDS AQUIFER FED	SEVERE-NO WATER
DRAINAGE	DEEP TO WATER
IRRIGATION	0-3% SL,FSL,L: ROOTING DEPTH 3+% SL,FSL,L: SLOPE,ROOTING DEPTH 0-3% LS: FAST INTAKE,ROOTING DEPTH 3+% LS: SLOPE,FAST INTAKE,ROOTING DEPTH
TERRACES AND DIVERSIONS	0-8% L: TOO SANDY 8+% L: SLOPE,TOO SANDY 0-8% SL,FSL,LS: TOO SANDY,SOIL BLOWING 8+% SL,FSL,LS: SLOPE,TOO SANDY,SOIL BLOWING
GRASSED WATERWAYS	0-8%: ROOTING DEPTH 8+%: SLOPE,ROOTING DEPTH

MLRA(S): 91, 95A, 95B, 97, 98, 103, 104, 105, 111
REV. LWB, 7-89
TYPIC MEDISAPRISTS, EUIC, MESIC

THE HOUGHTON SERIES CONSISTS OF VERY POORLY DRAINED SOILS FORMED IN HERBACEOUS ORGANIC DEPOSITS IN BOGS AND OTHER DEPRESSIONAL AREAS WITHIN OUTWASH PLAINS, LAKE PLAINS, TILL PLAINS AND MORAINES. THE SURFACE LAYER IS BLACK MUCK 9 INCHES THICK. THE UNDERLYING LAYERS ARE BLACK AND DARK REDDISH BROWN SAPRIC MATERIAL. SLOPES ARE 0 TO 2 PERCENT. MOST OF THESE SOILS ARE DRAINED AND USED FOR CROPLAND.

LANDSCAPE AND CLIMATE PROPERTIES

ANNUAL AIR TEMPERATURE	FROST FREE DAYS	ANNUAL PRECIPITATION	ELEVATION (FT)	DRAINAGE CLASS	SLOPE (PCT)
47-52	120-170	28-40	500-1000	VP	0-2

ESTIMATED SOIL PROPERTIES

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT. >10 IN (PCT)	FRACT. 3-10 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	CLAY (PCT)
0-9	MUCK	PT	A-8	0	0					-
0-9	MPT	PT	A-8	0	0					-
0-9	PEAT	PT	A-8	0	0					-
9-66	MUCK	PT	A-8	0	0					-

DEPTH (IN.)	LIQUID LIMIT	PLASTICITY INDEX	MOIST BULK DENSITY (G/CM3)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SAR	CEC (ME/100G)	CACO3 (PCT)	GYPSUM (PCT)
0-9			0.30-0.45	0.2-6.0	0.35-0.45	4.5-7.8	-	-	150-230	-	-
0-9			0.25-0.40	0.6-6.0	0.45-0.55	4.5-7.8	-	-	150-230	-	-
0-9			0.25-0.40	>6.0	0.55-0.65	4.5-7.8	-	-	80-120	-	-
9-66			0.15-0.30	0.2-6.0	0.35-0.45	4.5-7.8	-	-	100-200	-	-

DEPTH (IN.)	ORGANIC MATTER (PCT)	SHRINK-SWELL POTENTIAL	EROSION FACTORS K	T	WIND EROD. GROUP	WIND EROD. INDEX	CORROSIVITY STEEL	CONCRETE
0-9	>70		-	5	2	134	HIGH	MODERATE
0-9	>70		-	5	5	56		
0-9	>70		-	5	7	38		
9-66	>70		-					

FLOODING FREQUENCY	DURATION	MONTHS	HIGH WATER TABLE DEPTH (FT)	KIND	MONTHS	CEMENTED PAN DEPTH (IN)	HARDNESS	BEDROCK DEPTH (IN)	HARDNESS	SUBSIDENCE INIT. (IN)	TOTAL (IN)	HYD GRP	POTENT'L FROST ACTION
NONE			+1-1.0	APPARENT	SEP-JUN	-		>60		1-4	55-60	A/D	HIGH

SANITARY FACILITIES

SEPTIC TANK ABSORPTION FIELDS	SEVERE-SUBSIDES,PONDING,PERCS SLOWLY
SEWAGE LAGOON AREAS	SEVERE-SEEPAGE,PONDING,EXCESS HUMUS
SANITARY LANDFILL (TRENCH)	SEVERE-PONDING,EXCESS HUMUS
SANITARY LANDFILL (AREA)	SEVERE-PONDING,SEEPAGE
DAILY COVER FOR LANDFILL	POOR-PONDING,EXCESS HUMUS

BUILDING SITE DEVELOPMENT

SHALLOW EXCAVATIONS	SEVERE-PONDING,EXCESS HUMUS
DWELLINGS WITHOUT BASEMENTS	SEVERE-SUBSIDES,PONDING,LOW STRENGTH
DWELLINGS WITH BASEMENTS	SEVERE-SUBSIDES,PONDING,LOW STRENGTH
SMALL COMMERCIAL BUILDINGS	SEVERE-SUBSIDES,PONDING,LOW STRENGTH
LOCAL ROADS AND STREETS	SEVERE-SUBSIDES,PONDING,FROST ACTION
LAWNS, LANDSCAPING AND GOLF FAIRWAYS	SEVERE-EXCESS HUMUS,PONDING

CONSTRUCTION MATERIAL

ROADFILL	POOR-WETNESS,LOW STRENGTH
SAND	IMPROBABLE-EXCESS HUMUS
GRAVEL	IMPROBABLE-EXCESS HUMUS
TOPSOIL	POOR-WETNESS,EXCESS HUMUS

WATER MANAGEMENT

POND RESERVOIR AREA	SEVERE-SEEPAGE
EMBANKMENTS DIKES AND LEVEES	SEVERE-EXCESS HUMUS,PONDING
EXCAVATED PONDS AQUIFER FED	SEVERE-SLOW REFILL
DRAINAGE	FROST ACTION,SUBSIDES,PONDING
IRRIGATION	HM,MPT,FB,PEAT: PONDING SP,MUCK: PONDING,SOIL BLOWING
TERRACES AND DIVERSIONS	HM,MPT,FB,PEAT: PONDING SP,MUCK: PONDING,SOIL BLOWING
GRASSED WATERWAYS	WETNESS

MLRA(S): 97, 98
REV. LWB, 9-87
TYPIC HAPLUDALFS, FINE-LOAMY, MIXED, MESIC

KALAMAZOO SERIES

THE KALAMAZOO SERIES CONSISTS OF WELL DRAINED SOILS FORMED IN LOAMY OVER SANDY GLACIOFLUVIAL DEPOSITS ON OUTWASH PLAINS, TERRACES, VALLEY TRAINS AND LOW LYING MORAINES. THE SURFACE LAYER IS DARK GRAYISH BROWN LOAM 11 INCHES THICK. THE DARK YELLOWISH BROWN AND DARK BROWN SUBSOIL IS LOAM, CLAY LOAM AND SANDY LOAM IN UPPER 27 INCHES AND LOAMY COARSE SAND AND LOAMY SAND IN LOWER 17 INCHES. THE SUBSTRATUM IS DARK YELLOWISH BROWN COARSE SAND. SLOPES RANGE FROM 0 TO 18 PERCENT. CROPLAND IS THE MAIN USE.

ESTIMATED SOIL PROPERTIES (A)

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT >3 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	LIQUID LIMIT	PLAS-TICITY INDEX
0-11	L	ML, CL-ML, CL	A-4, A-6	0-5	95-100	70-100	65-90	50-70	<35	NP-15
0-11	SL	SM, SM-SC, SC	A-2-4, A-4, A-1-B	0-5	95-100	70-100	45-70	20-40	<30	NP-10
0-11	SIL	CL-ML, CL	A-4	0-5	95-100	90-100	80-100	65-90	20-30	4-10
11-38	CL, SCL, GR-SL	SC, CL	A-4, A-6, A-7, A-2	0-5	80-100	70-95	40-95	24-80	25-45	7-25
38-55	LCOS, LS, GR-LS	SM, SP-SM, SM-SC	A-2-4, A-1-B	0-5	80-100	60-95	30-70	10-30	<25	NP-7
55-60	S, GR-S	SP, SP-SM, GP, GP-GM	A-1, A-3, A-2	0-5	40-100	25-100	10-70	0-15	-	NP

DEPTH (IN.)	CLAY (PCT)	MOIST BULK DENSITY (G/CM3)	PERMEA-BILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SHRINK-SWELL POTENTIAL	EROSION FACTORS K	T	WIND EROD. GROUP	ORGANIC MATTER (PCT)	CORROSIVITY STEEL	CONCRETE
0-11	8-25	1.30-1.65	0.6-2.0	0.16-0.22	5.1-7.3	-	LOW	.32	4	5	1-3	LOW	LOW
0-11	8-20	1.30-1.65	2.0-6.0	0.10-0.15	5.1-7.3	-	LOW	.24	4	3	1-3		
0-11	10-20	1.20-1.40	0.6-2.0	0.22-0.24	5.1-7.3	-	LOW	.37	4	5	1-3		
11-38	18-35	1.35-1.70	0.6-2.0	0.10-0.18	5.1-7.3	-	MODERATE	.32					
38-55	2-15	1.50-1.65	6.0-20	0.02-0.08	5.1-7.8	-	LOW	.15					
55-60	0-10	1.50-1.65	6.0-20	0.01-0.03	7.4-8.4	-	LOW	.10					

FLOODING FREQUENCY	DURATION	MONTHS	HIGH WATER TABLE DEPTH (FT)	KIND	MONTHS	CEMENTED PAN DEPTH (IN)	HARDNESS	BEDROCK DEPTH (IN)	HARDNESS	SUBSIDENCE INIT. (IN)	TOTAL (IN)	HYD GRP	POTENT'L FROST ACTION
NONE			>6.0			-		>60		-		3	MODERATE

SANITARY FACILITIES

SEPTIC TANK ABSORPTION FIELDS	0-15%: SEVERE-POOR FILTER 15+%: SEVERE-POOR FILTER,SLOPE
SEWAGE LAGOON AREAS	0-7%: SEVERE-SEEPAGE 7+%: SEVERE-SEEPAGE,SLOPE
SANITARY LANDFILL (TRENCH)	0-15%: SEVERE-SEEPAGE 15+%: SEVERE-SEEPAGE,SLOPE
SANITARY LANDFILL (AREA)	0-15%: SEVERE-SEEPAGE 15+%: SEVERE-SEEPAGE,SLOPE
DAILY COVER FOR LANDFILL	0-15%: POOR-THIN LAYER 15+%: POOR-SLOPE,THIN LAYER

BUILDING SITE DEVELOPMENT

SHALLOW EXCAVATIONS	0-15%: SEVERE-CUTBANKS CAVE 15+%: SEVERE-CUTBANKS CAVE,SLOPE
DWELLINGS WITHOUT BASEMENTS	0-8%: MODERATE-SHRINK-SWELL 8-15%: MODERATE-SHRINK-SWELL,SLOPE 15+%: SEVERE-SLOPE
DWELLINGS WITH BASEMENTS	0-8%: MODERATE-SHRINK-SWELL 8-15%: MODERATE-SLOPE,SHRINK-SWELL 15+%: SEVERE-SLOPE
SMALL COMMERCIAL BUILDINGS	0-4%: MODERATE-SHRINK-SWELL 4-8%: MODERATE-SHRINK-SWELL,SLOPE 8+%: SEVERE-SLOPE
LOCAL ROADS AND STREETS	0-8%: MODERATE-SHRINK-SWELL,LOW STRENGTH 8-15%: MODERATE-SHRINK-SWELL,LOW STRENGTH, SLOPE 15+%: SEVERE-SLOPE
LAWNS, LANDSCAPING AND GOLF FAIRWAYS	0-8% SIL: SLIGHT 8-15% SIL: MODERATE-SLOPE 0-8% L,SL: MODERATE-SMALL STONES 8-15% L,SL: MODERATE-SMALL STONES,SLOPE 15+%: SEVERE-SLOPE

REGIONAL INTERPRETATIONS

CONSTRUCTION MATERIAL

ROADFILL	0-15%: GOOD 15-18%: FAIR-SLOPE
SAND	PROBABLE
GRAVEL	PROBABLE
TOPSOIL	0-15%: POOR-SMALL STONES,AREA RECLAIM 15+%: POOR-SMALL STONES,AREA RECLAIM,SLOPE

WATER MANAGEMENT

POND RESERVOIR AREA	0-8%: SEVERE-SEEPAGE 8+%: SEVERE-SEEPAGE,SLOPE
EMBANKMENTS DIKES AND LEVEES	SEVERE-THIN LAYER
EXCAVATED PONDS AQUIFER FED	SEVERE-NO WATER
DRAINAGE	DEEP TO WATER
IRRIGATION	0-3% L,SIL: FAVORABLE 3+% L,SIL: SLOPE 0-3% SL: DROUGHTY 3+% SL: SLOPE,DROUGHTY
TERRACES AND DIVERSIONS	0-8% L,SL: FAVORABLE 8+% L,SL: SLOPE 0-8% SIL: ERODES EASILY 8+% SIL: SLOPE,ERODES EASILY
GRASSED WATERWAYS	0-8% L,SL: FAVORABLE 8+% L,SL: SLOPE 0-8% SIL: ERODES EASILY 8+% SIL: SLOPE,ERODES EASILY

MI0041 SOIL INTERPRETATIONS RECORD

MLRA(S): 97, 98, 99, 111 KIBBIE SERIES
REV. LWB, 2-89
AQUOLLIC HAPLUDALFS, FINE-LOAMY, MIXED, MESIC

THE KIBBIE SERIES CONSISTS OF SOMEWHAT POORLY DRAINED SOILS FORMED IN LOAMY GLACIOFLUVIAL DEPOSITS ON LAKE PLAINS. OUTWASH PLAINS AND DELTAS. THE SURFACE LAYER IS VERY DARK GRAYISH BROWN LOAM 7 INCHES THICK. THE SUBSURFACE LAYER IS GRAYISH BROWN MOTTLED LOAM 4 INCHES THICK. THE SUBSOIL IS BROWN MOTTLED SILT LOAM AND SILTY CLAY LOAM 25 INCHES THICK. THE SUBSTRATUM IS BROWN MOTTLED STRATIFIED SILT LOAM, FINE SAND AND VERY FINE SAND. SLOPES RANGE FROM 0 TO 6 PERCENT. MOST OF THE SOILS ARE USED FOR CROPLAND.

ESTIMATED SOIL PROPERTIES (A)

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT >3 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX
0-11	L, SIL	ML, CL, CL-ML	A-4, A-6	0	100	100	85-100	60-95	<35	NP-15
0-11	LFS	SM, SM-SC	A-4, A-2	0	100	100	70-95	30-45	<25	NP-7
0-11	FSL, SL, VFSL	SM, ML, SC, CL	A-4, A-6	0	100	100	75-95	40-60	<30	NP-11
11-34	SIL, SICL, SCL	CL, SC	A-4, A-6, A-7	0	90-100	85-100	80-100	35-90	25-45	9-25
34-60	SR-SIL-FS	ML, SM, SC, CL	A-4, A-2	0	100	95-100	70-95	30-80	<30	NP-10

DEPTH (IN.)	CLAY (PCT)	MOIST BULK DENSITY (G/CM3)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SHRINK-SWELL POTENTIAL	EROSION FACTORS K	T	WIND EROD. GROUP	ORGANIC MATTER (PCT)	CORROSIVITY STEEL	CONCRETE
0-11	5-25	1.40-1.65	0.6-2.0	0.16-0.24	5.6-7.3	-	LOW	.28	5	5	2-3	HIGH	MODERATE
0-11	0-15	1.40-1.65	2.0-6.0	0.13-0.18	5.6-7.3	-	LOW	.17	5	2	2-3		
0-11	2-20	1.40-1.65	0.6-2.0	0.16-0.20	5.6-7.3	-	LOW	.20	5	3	2-3		
11-34	18-35	1.40-1.65	0.6-2.0	0.17-0.22	5.6-7.3	-	LOW	.43					
34-60	2-18	1.40-1.70	0.6-2.0	0.12-0.22	7.4-8.4	-	LOW	.43					

FLOODING FREQUENCY	DURATION	MONTHS	HIGH WATER TABLE DEPTH (FT)	KIND	MONTHS	CEMENTED PAN DEPTH (IN)	HARDNESS	BEDROCK DEPTH (IN)	HARDNESS	SUBSIDENCE INIT. (IN)	TOTAL (IN)	HYD GRP	POTENT'L FROST ACTION
NONE			1.0-2.0	APPARENT	NOV-MAY	-		>60		-		B	HIGH

SANITARY FACILITIES

SEPTIC TANK ABSORPTION FIELDS	SEVERE-WETNESS
SEWAGE LAGOON AREAS	SEVERE-WETNESS
SANITARY LANDFILL (TRENCH)	SEVERE-WETNESS,TOO SANDY
SANITARY LANDFILL (AREA)	SEVERE-WETNESS
DAILY COVER FOR LANDFILL	POOR-TOO SANDY,WETNESS

BUILDING SITE DEVELOPMENT

SHALLOW EXCAVATIONS	SEVERE-CUTBANKS CAVE,WETNESS
DWELLINGS WITHOUT BASEMENTS	SEVERE-WETNESS
DWELLINGS WITH BASEMENTS	SEVERE-WETNESS
SMALL COMMERCIAL BUILDINGS	SEVERE-WETNESS
LOCAL ROADS AND STREETS	SEVERE-FROST ACTION
LAWNS, LANDSCAPING AND GOLF FAIRWAYS	MODERATE-WETNESS

REGIONAL INTERPRETATIONS

CONSTRUCTION MATERIAL

ROADFILL	FAIR-WETNESS
SAND	IMPROBABLE-EXCESS FINES
GRAVEL	IMPROBABLE-EXCESS FINES
TOPSOIL	FAIR-SMALL STONES,THIN LAYER

WATER MANAGEMENT

POND RESERVOIR AREA	0-3%: MODERATE-SEEPAGE 3-6%: MODERATE-SEEPAGE,SLOPE
EMBANKMENTS DIKES AND LEVEES	SEVERE-PIPING,WETNESS
EXCAVATED PONDS AQUIFER FED	SEVERE-CUTBANKS CAVE
DRAINAGE	0-3%: FROST ACTION,CUTBANKS CAVE 3+%: FROST ACTION,SLOPE,CUTBANKS CAVE
IRRIGATION	0-3% L,SIL,FSL,SL,VFSL: WETNESS 3+% L,SIL,FSL,SL,VFSL: SLOPE,WETNESS 0-3% LFS: WETNESS,FAST INTAKE 3+% LFS: SLOPE,WETNESS,FAST INTAKE
TERRACES AND DIVERSIONS	ERODES EASILY,WETNESS,TOO SANDY
GRASSED WATERWAYS	WETNESS,ERODES EASILY

MI0253

S O I L   I N T E R P R E T A T I O N S   R E C O R D

MLRA(S): 98, 111
REV. LWB, 2-89
TYPIC HAPLUDALFS, LOAMY-SKELETAL, MIXED, MESIC

LEONI SERIES

THE LEONI SERIES CONSISTS OF WELL DRAINED SOILS FORMED IN GLACIOFLUVIAL MATERIAL ON UPLANDS. THE SURFACE SOIL IS VERY DARK GRAYISH AND BROWN GRAVELLY SANDY LOAM 13 INCHES THICK. THE SUBSOIL IS BROWN GRAVELLY SANDY LOAM 29 INCHES THICK. THE SUBSTRATUM IS DARK YELLOWISH BROWN VERY GRAVELLY LOAMY SAND. SLOPES RANGE FROM 0 TO 40 PERCENT. AREAS ARE IN CROPLAND, WOODLAND AND PASTURELAND.

ESTIMATED SOIL PROPERTIES

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT >3 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX
0-13	GR-SL	SM, SC, SM-SC	A-2, A-1	3-10	85-95	55-85	35-60	13-35	<30	NP-10
0-13	GR-LS	SM, SM-SC, SP-SM	A-2, A-1, A-3	5-10	85-95	55-85	30-65	5-35	<25	NP-7
0-13	GRV-SL	SM, SC, SM-SC	A-2, A-1	5-10	60-65	35-50	25-40	5-30	<30	NP-10
13-29	CB-CL, GR-SCL, GR-CL	CL, SC, GC	A-6, A-4, A-7	5-30	70-85	60-85	50-70	40-60	25-45	7-22
29-42	GR-SL, GR-SCL, CB-CL	SC, CL, GC	A-6, A-4, A-7	5-30	70-85	60-85	50-70	40-60	23-45	7-22
42-60	GR-S, CB-LS, CB-SL	SM, SP-SM, SC, SM-SC	A-1, A-2, A-4	5-35	65-85	40-75	35-50	5-40	<30	NP-10

DEPTH (IN.)	CLAY (PCT)	MOIST BULK DENSITY (G/CM3)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SHRINK-SWELL POTENTIAL	EROSION FACTORS K	T	WIND EROD. GROUP	ORGANIC MATTER (PCT)	CORROSIVITY STEEL	CONCRETE
0-13	2-18	1.40-1.70	0.6-6.0	0.08-0.12	5.6-7.3	-	LOW	.17	5	8	1-3	LOW	MODERATE
0-13	2-15	1.40-1.70	2.0-6.0	0.06-0.08	5.6-7.3	-	LOW	.10	5	8	1-3		
0-13	2-18	1.40-1.70	0.6-6.0	0.06-0.10	5.6-7.3	-	LOW	.17	5	8	1-3		
13-29	18-35	1.40-1.70	0.6-2.0	0.06-0.12	5.1-7.3	-	LOW	.24					
29-42	18-35	1.40-1.70	2.0-6.0	0.03-0.09	5.6-7.8	-	LOW	.24					
42-60	0-18	1.40-1.60	2.0-20	0.01-0.03	7.4-8.4	-	LOW	.10					

FLOODING FREQUENCY	DURATION	MONTHS	HIGH WATER TABLE DEPTH (FT)	KIND	MONTHS	CEMENTED PAN DEPTH (IN)	HARDNESS	BEDROCK DEPTH (IN)	HARDNESS	SUBSIDENCE INIT. (IN)	TOTAL (IN)	HYD GRP	POTENT'L FROST ACTION
NONE			>5.0			-		>60		-		B	MODERATE

SANITARY FACILITIES

SEPTIC TANK ABSORPTION FIELDS	0-8%: MODERATE-PERCS SLOWLY 8-15%: MODERATE-PERCS SLOWLY,SLOPE 15+%: SEVERE-SLOPE
SEWAGE LAGOON AREAS	0-7%: SEVERE-SEEPAGE 7+%: SEVERE-SEEPAGE,SLOPE
SANITARY LANDFILL (TRENCH)	0-15%: SEVERE-SEEPAGE,TOO SANDY 15+%: SEVERE-SEEPAGE,SLOPE,TOO SANDY
SANITARY LANDFILL (AREA)	0-15%: SEVERE-SEEPAGE 15+%: SEVERE-SEEPAGE,SLOPE
DAILY COVER FOR LANDFILL	POOR-SEEPAGE,TOO SANDY,SMALL STONES

BUILDING SITE DEVELOPMENT

SHALLOW EXCAVATIONS	0-15%: SEVERE-CUTBANKS CAVE 15+%: SEVERE-CUTBANKS CAVE,SLOPE
DWELLINGS WITHOUT BASEMENTS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE
DWELLINGS WITH BASEMENTS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE
SMALL COMMERCIAL BUILDINGS	0-4%: SLIGHT 4-8%: MODERATE-SLOPE 8+%: SEVERE-SLOPE
LOCAL ROADS AND STREETS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE
LAWNS LANDSCAPING AND GOLF FAIRWAYS	0-8%: MODERATE-SMALL STONES,LARGE STONES 8-15%: MODERATE-SMALL STONES,LARGE STONES, SLOPE 15+%: SEVERE-SLOPE

CONSTRUCTION MATERIAL

ROADFILL	0-15%: GOOD 15-25%: FAIR-SLOPE 25+%: POOR-SLOPE
SAND	PROBABLE
GRAVEL	PROBABLE
TOPSOIL	0-15%: POOR-SMALL STONES,AREA RECLAIM 15+%: POOR-SMALL STONES,AREA RECLAIM,SLOPE

WATER MANAGEMENT

POND RESERVOIR AREA	0-8%: SEVERE-SEEPAGE 8+%: SEVERE-SEEPAGE,SLOPE
EMBANKMENTS DIKES AND LEVEES	SEVERE-SEEPAGE
EXCAVATED PONDS AQUIFER FED	SEVERE-NO WATER
DRAINAGE	DEEP TO WATER
IRRIGATION	0-3% GR-SL: DROUGHTY 3+% GR-SL: SLOPE,DROUGHTY 0-3% GR-LS: DROUGHTY,FAST INTAKE 3+% GR-LS: SLOPE,DROUGHTY,FAST INTAKE
TERRACES AND DIVERSIONS	0-8%: LARGE STONES,TOO SANDY 8+%: SLOPE,LARGE STONES,TOO SANDY
GRASSED WATERWAYS	0-8%: LARGE STONES,DROUGHTY 8+%: LARGE STONES,SLOPE,DROUGHTY

REGIONAL INTERPRETATIONS

MI0037 SOIL INTERPRETATIONS RECORD

MLRA(S): 95A, 95B, 98, 97, 111 MATHERTON SERIES
REV. LWB, 2-89
UDOLLIC OCHRAQUALFS, FINE-LOAMY OVER SANDY OR SANDY-SKELETAL, MIXED, MESIC

THE MATHERTON SERIES CONSISTS OF SOMEWHAT POORLY DRAINED SOILS FORMED IN LOAMY AND SANDY GLACIOFLUVIAL DEPOSITS ON OUTWASH PLAINS, VALLEY TRAINS AND TERRACES. THE SURFACE LAYER IS VERY DARK GRAYISH BROWN SANDY LOAM 8 INCHES THICK. THE SUBSURFACE LAYER IS GRAYISH BROWN LOAM 3 INCHES THICK. THE SUBSOIL IS BROWN AND GRAYISH BROWN MOTTLED SANDY CLAY LOAM AND GRAVELLY CLAY LOAM 24 INCHES THICK. THE SUBSTRATUM IS LIGHT GRAY GRAVELLY SAND. SLOPES RANGE FROM 0 TO 6 PERCENT. MOST AREAS ARE USED FOR CROPLAND.

ESTIMATED SOIL PROPERTIES

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT >3 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX
0-11	L	CL, CL-ML	A-4, A-6	0-5	90-100	75-100	65-95	50-75	20-30	4-11
0-11	SIL	CL, CL-ML	A-4, A-6	0-5	90-100	75-100	70-100	50-90	20-30	4-11
0-11	SL	SM, SM-SC	A-2, A-4, A-1	0-5	90-100	75-100	45-70	20-40	<25	NP-7
11-35	SCL, GR-CL, L	SC, CL	A-6, A-2, A-7	0-5	85-95	60-90	50-90	30-75	30-45	10-25
35-60	GR-S, S, GRV-S	GP, SP, SP-SM, GP-GM	A-1, A-3, A-2-4	0-10	40-100	25-75	20-55	0-15	-	NP

DEPTH (IN.)	CLAY (PCT)	MOIST BULK DENSITY (G/CM3)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SHRINK-SWELL POTENTIAL	EROSION FACTORS K	T	WIND EROD. GROUP	ORGANIC MATTER (PCT)	CORROSIVITY STEEL	CONCRETE
0-11	10-20	1.30-1.65	2.0-6.0	0.13-0.22	5.1-7.3	-	LOW	.28	4	5	2-4	MODERATE	LOW
0-11	12-20	1.30-1.65	2.0-6.0	0.15-0.24	5.1-7.3	-	LOW	.32	4	5	2-4		
0-11	10-20	1.40-1.65	2.0-6.0	0.13-0.15	5.1-7.3	-	LOW	.20	4	3	2-4		
11-35	20-35	1.40-1.70	0.6-2.0	0.12-0.18	5.1-7.3	-	MODERATE	.24					
35-60	0-10	1.50-1.65	>6.0	0.02-0.04	7.4-8.4	-	LOW	.10					

FLOODING FREQUENCY	DURATION	MONTHS	HIGH WATER TABLE DEPTH (FT)	KIND	MONTHS	CEMENTED PAN DEPTH (IN)	HARDNESS	BEDROCK DEPTH (IN)	HARDNESS	SUBSIDENCE INIT. (IN)	TOTAL (IN)	HYD GRP	POTENT'L FROST ACTION
NONE			1.0-2.0	APPARENT	NOV-MAY	-		>60		-		B	HIGH

SANITARY FACILITIES

SEPTIC TANK ABSORPTION FIELDS	SEVERE-WETNESS,POOR FILTER
SEWAGE LAGOON AREAS	SEVERE-SEEPAGE,WETNESS
SANITARY LANDFILL (TRENCH)	SEVERE-SEEPAGE,WETNESS,TOO SANDY
SANITARY LANDFILL (AREA)	SEVERE-SEEPAGE,WETNESS
DAILY COVER FOR LANDFILL	POOR-SEEPAGE,TOO SANDY,SMALL STONES

BUILDING SITE DEVELOPMENT

SHALLOW EXCAVATIONS	SEVERE-CUTBANKS CAVE,WETNESS
DWELLINGS WITHOUT BASEMENTS	SEVERE-WETNESS
DWELLINGS WITH BASEMENTS	SEVERE-WETNESS
SMALL COMMERCIAL BUILDINGS	SEVERE-WETNESS
LOCAL ROADS AND STREETS	SEVERE-FROST ACTION
LAWNS, LANDSCAPING AND GOLF FAIRWAYS	MODERATE-WETNESS

CONSTRUCTION MATERIAL

ROADFILL	FAIR-WETNESS
SAND	PROBABLE
GRAVEL	PROBABLE
TOPSOIL	POOR-SMALL STONES,AREA RECLAIM

WATER MANAGEMENT

POND RESERVOIR AREA	SEVERE-SEEPAGE
EMBANKMENTS DIKES AND LEVEES	SEVERE-SEEPAGE,WETNESS
EXCAVATED PONDS AQUIFER FED	SEVERE-CUTBANKS CAVE
DRAINAGE	0-3%: FROST ACTION,CUTBANKS CAVE 3+%: FROST ACTION,SLOPE,CUTBANKS CAVE
IRRIGATION	0-3% L,SIL: WETNESS 3+% L,SIL: SLOPE,WETNESS 0-3% SL: WETNESS,SOIL BLOWING 3+% SL: SLOPE,WETNESS,SOIL BLOWING
TERRACES AND DIVERSIONS	L,SIL: WETNESS,TOO SANDY SL: WETNESS,TOO SANDY,SOIL BLOWING
GRASSED WATERWAYS	WETNESS

REGIONAL INTERPRETATIONS

MLRA(S): 95B, 97, 98, 108, 110, 111
REV. JCD, 10-87
TYPIC HAPLUDALFS, FINE, ILLITIC, MESIC

MORLEY SERIES
WELL DRAINED

THE MORLEY SERIES, WELL DRAINED, CONSISTS OF WELL DRAINED SOILS FORMED IN GLACIAL TILL ON UPLANDS. THE SURFACE LAYER IS VERY DARK GRAY SILT LOAM 4 INCHES THICK. THE SUBSURFACE LAYER IS GRAYISH BROWN SILT LOAM 5 INCHES THICK. THE SUBSOIL IS BROWN SILTY CLAY LOAM AND SILTY CLAY 33 INCHES THICK. THE SUBSTRATUM IS BROWN SILTY CLAY LOAM. SLOPES RANGE FROM 1 TO 50 PERCENT. MOST AREAS ARE USED FOR CROPLAND.

ESTIMATED SOIL PROPERTIES

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT >3 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX
0-9	SIL, L	CL, CL-ML	A-6, A-4	0-5	95-100	95-100	90-100	75-95	25-40	5-15
0-9	CL	CL	A-6, A-7	0-5	95-100	90-100	85-95	80-90	30-45	15-25
0-9	SICL	CL	A-6, A-7	0-5	95-100	90-100	85-95	80-90	30-45	15-25
9-14	SICL, CL	CL	A-6, A-7	0-10	95-100	90-100	85-95	80-90	30-50	15-30
14-42	SICL, SIC, C	CL, CH	A-6, A-7	0-10	95-100	90-100	85-95	80-90	30-60	15-35
42-60	SICL, CL	CL	A-6, A-7	0-10	95-100	90-100	85-95	80-90	30-50	15-30

DEPTH (IN.)	CLAY (PCT)	MOIST BULK DENSITY (G/CM3)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SHRINK-SWELL POTENTIAL	EROSION FACTORS K	T	WIND EROD. GROUP	ORGANIC MATTER (PCT)	CORROSIVITY STEEL	CONCRETE
0-9	22-27	1.35-1.55	0.6-2.0	0.20-0.24	5.1-6.5	-	LOW	.43	4	6	1-3	HIGH	MODERATE
0-9	27-35	1.40-1.60	0.2-0.6	0.18-0.20	5.1-6.5	-	MODERATE	.32	4	6	1-2		
0-9	27-35	1.35-1.50	0.2-0.6	0.20-0.22	5.1-6.5	-	MODERATE	.37	4	7	1-2		
9-14	27-40	1.45-1.65	0.2-0.6	0.18-0.20	5.1-6.5	-	MODERATE	.43					
14-42	35-50	1.55-1.70	0.06-0.6	0.11-0.15	6.1-8.4	-	MODERATE	.43					
42-60	27-40	1.60-1.80	0.06-0.6	0.07-0.12	6.1-8.4	-	MODERATE	.43					

FLOODING FREQUENCY	DURATION	MONTHS	HIGH WATER TABLE DEPTH (FT)	KIND	MONTHS	CEMENTED PAN DEPTH (IN)	HARDNESS	BEDROCK DEPTH (IN)	HARDNESS	SUBSIDENCE INIT. (IN)	TOTAL (IN)	HYD GRP	POTENT'L FROST ACTION
NONE			>6.0			-		>60		-		C	MODERATE

SANITARY FACILITIES

SEPTIC TANK ABSORPTION FIELDS	1-15%: SEVERE-PERCS SLOWLY 15+%: SEVERE-PERCS SLOWLY,SLOPE
SEWAGE LAGOON AREAS	1-2%: SLIGHT 2-7%: MODERATE-SLOPE 7+%: SEVERE-SLOPE
SANITARY LANDFILL (TRENCH)	1-15%: SEVERE-TOO CLAYEY 15+%: SEVERE-SLOPE,TOO CLAYEY
SANITARY LANDFILL (AREA)	1-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE
DAILY COVER FOR LANDFILL	1-15%: POOR-TOO CLAYEY,HARD TO PACK 15+%: POOR-SLOPE,TOO CLAYEY,HARD TO PACK

BUILDING SITE DEVELOPMENT

SHALLOW EXCAVATIONS	1-8%: MODERATE-TOO CLAYEY 8-15%: MODERATE-TOO CLAYEY,SLOPE 15+%: SEVERE-SLOPE
DWELLINGS WITHOUT BASEMENTS	1-8%: MODERATE-SHRINK-SWELL 8-15%: MODERATE-SHRINK-SWELL,SLOPE 15+%: SEVERE-SLOPE
DWELLINGS WITH BASEMENTS	1-8%: MODERATE-SHRINK-SWELL 8-15%: MODERATE-SLOPE,SHRINK-SWELL 15+%: SEVERE-SLOPE
SMALL COMMERCIAL BUILDINGS	1-4%: MODERATE-SHRINK-SWELL 4-8%: MODERATE-SHRINK-SWELL,SLOPE 8+%: SEVERE-SLOPE
LOCAL ROADS AND STREETS	1-15%: SEVERE-LOW STRENGTH 15+%: SEVERE-LOW STRENGTH,SLOPE
LAWNS, LANDSCAPING AND GOLF FAIRWAYS	1-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE

CONSTRUCTION MATERIAL

ROADFILL	1-25%: POOR-LOW STRENGTH 25+%: POOR-LOW STRENGTH,SLOPE
SAND	IMPROBABLE-EXCESS FINES
GRAVEL	IMPROBABLE-EXCESS FINES
TOPSOIL	1-15%: POOR-THIN LAYER 15+%: POOR-THIN LAYER,SLOPE

WATER MANAGEMENT

POND RESERVOIR AREA	1-3%: SLIGHT 3-8%: MODERATE-SLOPE 8+%: SEVERE-SLOPE
EMBANKMENTS DIKES AND LEVEES	MODERATE-HARD TO PACK
EXCAVATED PONDS AQUIFER FED	SEVERE-NO WATER
DRAINAGE	DEEP TO WATER
IRRIGATION	1-3%: PERCS SLOWLY 3+%: SLOPE,PERCS SLOWLY
TERRACES AND DIVERSIONS	1-8%: ERODES EASILY 8+%: SLOPE,ERODES EASILY
GRASSED WATERWAYS	1-8%: ERODES EASILY,PERCS SLOWLY 8+%: SLOPE,ERODES EASILY,PERCS SLOWLY

REGIONAL INTERPRETATIONS

MI0033

SOIL INTERPRETATIONS RECORD

MLRA(S): 91, 95B, 97, 98, 111 OSHTEMO SERIES
REV. LWB, 2-89
TYPIC HAPLUDALFS, COARSE-LOAMY, MIXED, MESIC

THE OSHTEMO SERIES CONSISTS OF WELL DRAINED SOILS FORMED IN LOAMY AND SANDY GALCIOFLUVIAL DEPOSITS ON OUTWASH PLAINS, VALLEY TRAINS AND MORAINES. THE SURFACE LAYER IS DARK GRAYISH BROWN SANDY LOAM 9 INCHES THICK. THE SUBSURFACE LAYER IS BROWN SANDY LOAM 5 INCHES THICK. THE SUBSOIL IS DARK REDDISH BROWN SANDY LOAM IN UPPER 21 INCHES AND DARK BROWN LOAMY SAND IN LOWER 25 INCHES. THE SUBSTRATUM IS GRAYISH BROWN COARSE SAND AND FINE GRAVEL. SLOPES RANGE FROM 0 TO 55 PERCENT. CROPLAND IS THE MAIN USE.

ESTIMATED SOIL PROPERTIES

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT >3 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX
0-14	SL, FSL	SM, SM-SC, ML, CL-ML	A-2, A-4	0	95-100	85-95	50-85	25-55	<20	NP-4
0-14	LS, LFS	SM, SP-SM	A-2, A-1, A-4	0	95-100	85-95	40-80	10-40	-	NP
14-35	SL, SCL, GR-SL	SC, SM-SC	A-2, A-4, A-1	0	80-100	55-95	35-85	15-50	20-30	4-10
35-60	LS, SL, GR-LS	SM, SP-SM	A-2, A-1	0	80-95	55-95	35-70	10-35	-	NP
60-99	SR-S-G	SP-SM, GP, SP, GP-GM	A-1, A-2, A-3	0-5	40-90	35-85	20-60	0-10	-	NP

DEPTH (IN.)	CLAY (PCT)	MOIST BULK DENSITY (G/CM3)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SHRINK-SWELL POTENTIAL	EROSION FACTORS K	T	WIND EROD. GROUP	ORGANIC MATTER (PCT)	CORROSIVITY STEEL	CONCRETE
0-14	2-12	1.35-1.60	2.0-6.0	0.10-0.15	5.1-7.3	-	LOW	.24	5	3	.5-3	LOW	HIGH
0-14	2-10	1.35-1.60	6.0-20	0.10-0.12	5.1-6.5	-	LOW	.17	5	2	.5-3		
14-35	10-18	1.30-1.60	2.0-6.0	0.12-0.19	5.1-6.5	-	LOW	.24					
35-60	5-15	1.30-1.60	2.0-6.0	0.06-0.10	5.1-7.3	-	LOW	.17					
60-99	0-15	1.30-1.50	>20	0.02-0.04	7.4-8.4	-	LOW	.10					

FLOODING FREQUENCY	DURATION	MONTHS	HIGH WATER TABLE DEPTH (FT)	KIND	MONTHS	CEMENTED PAN DEPTH (IN)	HARDNESS	BEDROCK DEPTH (IN)	HARDNESS	SUBSIDENCE INIT. (IN)	TOTAL (IN)	HYD GRP	POTENT'L FROST ACTION
NONE			>6.0			-		>60		-		B	MODERATE

SANITARY FACILITIES

SEPTIC TANK ABSORPTION FIELDS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE
SEWAGE LAGOON AREAS	0-7%: SEVERE-SEEPAGE 7+%: SEVERE-SEEPAGE,SLOPE
SANITARY LANDFILL (TRENCH)	0-15%: SEVERE-SEEPAGE 15+%: SEVERE-SEEPAGE,SLOPE
SANITARY LANDFILL (AREA)	0-15%: SEVERE-SEEPAGE 15+%: SEVERE-SEEPAGE,SLOPE
DAILY COVER FOR LANDFILL	0-15%: POOR-SEEPAGE 15+%: POOR-SEEPAGE,SLOPE

BUILDING SITE DEVELOPMENT

SHALLOW EXCAVATIONS	0-15%: SEVERE-CUTBANKS CAVE 15+%: SEVERE-CUTBANKS CAVE,SLOPE
DWELLINGS WITHOUT BASEMENTS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE
DWELLINGS WITH BASEMENTS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE
SMALL COMMERCIAL BUILDINGS	0-4%: SLIGHT 4-8%: MODERATE-SLOPE 8+%: SEVERE-SLOPE
LOCAL ROADS AND STREETS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE
LAWNS, LANDSCAPING AND GOLF FAIRWAYS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE

CONSTRUCTION MATERIAL

ROADFILL	0-15%: GOOD 15-25%: FAIR-SLOPE 25+%: POOR-SLOPE
SAND	PROBABLE
GRAVEL	PROBABLE
TOPSOIL	0-15%: POOR-SMALL STONES 15+%: POOR-SMALL STONES,SLOPE

WATER MANAGEMENT

POND RESERVOIR AREA	0-8%: SEVERE-SEEPAGE 8+%: SEVERE-SEEPAGE,SLOPE
EMBANKMENTS DIKES AND LEVEES	SEVERE-SEEPAGE,PIPING
EXCAVATED PONDS AQUIFER FED	SEVERE-NO WATER
DRAINAGE	DEEP TO WATER
IRRIGATION	0-3% SL,FSL: SOIL BLOWING 3+% SL,FSL: SLOPE,SOIL BLOWING 0-3% LS,LFS: FAST INTAKE,SOIL BLOWING 3+% LS,LFS: SLOPE,FAST INTAKE,SOIL BLOWING
TERRACES AND DIVERSIONS	0-8%: TOO SANDY,SOIL BLOWING 8+%: SLOPE,TOO SANDY,SOIL BLOWING
GRASSED WATERWAYS	0-8%: FAVORABLE 8+%: SLOPE

REGIONAL INTERPRETATIONS

MI0388 SOIL INTERPRETATIONS RECORD

MLRA(S): 101, 108, 110, 115, 127, 140, 142, 144A, 145
REV. LWB, 2-89
TERRIC MEDISAPRISTS, LOAMY, MIXED, EUIC, MESIC

PALMS SERIES
MAAT>50

THE PALMS SERIES CONSISTS OF VERY POORLY DRAINED SOILS FORMED IN DEPOSITS OF ORGANIC MATERIAL, 16 TO 50 INCHES THICK, OVER LOAMY MINERAL DEPOSITS IN DEPRESSIONAL AREAS WITHIN LAKE PLAINS, TILL PLAINS AND MORAINES. THE SURFACE SOIL IS BLACK MUCK 35 INCHES THICK. THE SUBSTRATUM IS GRAY MOTTLED CLAY LOAM. SLOPES RANGE FROM 0 TO 6 PERCENT. DRAINED AREAS ARE USED FOR CROPLAND AND UNDRAINED AREAS ARE USED MAINLY AS WETLAND WILDLIFE HABITAT.

ESTIMATED SOIL PROPERTIES (A)

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT >3 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	LIQUID LIMIT	PLAS-TICITY INDEX
0-35	SP, MUCK	PT								
35-60	CL, SICL, FSL	CL-ML, CL	A-4, A-6	0	85-100	80-100	70-95	50-90	25-40	5-20

DEPTH (IN.)	CLAY (PCT)	MOIST BULK DENSITY (G/CM3)	PERMEA-BILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SHRINK-SWELL POTENTIAL	EROSION FACTORS K	T	WIND EROD. GROUP	ORGANIC MATTER (PCT)	CORROSIVITY STEEL	CONCRETE
0-35	-	0.25-0.45	0.2-6.0	0.35-0.45	5.1-7.8	-		-	5	2	>75	HIGH	MODERATE
35-60	7-35	1.45-1.75	0.2-2.0	0.14-0.22	6.1-8.4	-	LOW	.37					

FLOODING FREQUENCY	DURATION	MONTHS	HIGH WATER TABLE DEPTH (FT)	KIND	MONTHS	CEMENTED PAN DEPTH (IN)	HARDNESS	BEDROCK DEPTH (IN)	HARDNESS	SUBSIDENCE INIT. (IN)	TOTAL (IN)	HYD GRP	POTENT'L FROST ACTION
NONE-RARE			+1-1.0	APPARENT	NOV-MAY	-		>60		2-4	25-32	A/D	HIGH

SANITARY FACILITIES

SEPTIC TANK ABSORPTION FIELDS	SEVERE-SUBSIDES, PONDING, PERCS SLOWLY
SEWAGE LAGOON AREAS	SEVERE-SEEPAGE, EXCESS HUMUS, PONDING
SANITARY LANDFILL (TRENCH)	SEVERE-PONDING, EXCESS HUMUS
SANITARY LANDFILL (AREA)	SEVERE-SEEPAGE, PONDING
DAILY COVER FOR LANDFILL	POOR-PONDING, EXCESS HUMUS

CONSTRUCTION MATERIAL

ROADFILL	POOR-WETNESS
SAND	IMPROBABLE-EXCESS HUMUS
GRAVEL	IMPROBABLE-EXCESS HUMUS
TOPSOIL	POOR-EXCESS HUMUS, WETNESS

BUILDING SITE DEVELOPMENT

SHALLOW EXCAVATIONS	SEVERE-EXCESS HUMUS, PONDING
DWELLINGS WITHOUT BASEMENTS	NONE: SEVERE-SUBSIDES, PONDING RARE: SEVERE-SUBSIDES, FLOODING, PONDING
DWELLINGS WITH BASEMENTS	NONE: SEVERE-SUBSIDES, PONDING RARE: SEVERE-SUBSIDES, FLOODING, PONDING
SMALL COMMERCIAL BUILDINGS	NONE: SEVERE-SUBSIDES, PONDING RARE: SEVERE-SUBSIDES, FLOODING, PONDING
LOCAL ROADS AND STREETS	SEVERE-SUBSIDES, PONDING, FROST ACTION
LAWNS, LANDSCAPING AND GOLF FAIRWAYS	SEVERE-PONDING, EXCESS HUMUS

WATER MANAGEMENT

POND RESERVOIR AREA	SEVERE-SEEPAGE
EMBANKMENTS DIKES AND LEVEES	SEVERE-EXCESS HUMUS, PONDING
EXCAVATED PONDS AQUIFER FED	SEVERE-SLOW REFILL
DRAINAGE	PONDING, SUBSIDES, FROST ACTION
IRRIGATION	0-3%: PONDING, SOIL BLOWING 3+%: SLOPE, PONDING, SOIL BLOWING
TERRACES AND DIVERSIONS	PONDING, SOIL BLOWING
GRASSED WATERWAYS	WETNESS, ROOTING DEPTH

REGIONAL INTERPRETATIONS

MLRA(S): 95A, 95B, 98, 99, 108, 110, 111 — PELLA SERIES
REV. JCD, 6-87
TYPIC HAPLAQUOLLS, FINE-SILTY, MIXED, MESIC

THE PELLA SERIES CONSISTS OF DEEP, POORLY DRAINED SOILS FORMED IN LOAMY MATERIAL AND STRATIFIED OUTWASH ON UPLANDS. THE SURFACE LAYER IS BLACK CLAY LOAM 13 INCHES THICK. THE SUBSOIL IS VERY DARK GRAY AND OLIVE GRAY MOTTLED SILTY CLAY LOAM IN UPPER 18 INCHES AND GRAY MOTTLED SILT LOAM AND LOAM IN LOWER 7 INCHES. THE SUBSTRATUM IS GRAY AND OLIVE GRAY MOTTLED STRATIFIED SANDY LOAM, SILT LOAM AND CLAY LOAM. SLOPES RANGE FROM 0 TO 3 PERCENT. CROPLAND IS THE MAIN USE.

ESTIMATED SOIL PROPERTIES

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT >3 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX
0-13	SICL	CL	A-7	0	100	95-100	90-100	85-95	40-50	15-25
0-13	CL	CL	A-7	0	100	95-100	90-100	85-95	40-50	15-25
0-13	SIL	CL	A-6, A-7	0	100	95-100	90-100	85-95	30-45	10-20
13-31	SICL, SIC, CL	CL	A-6, A-7	0	100	95-100	90-100	85-95	30-50	15-30
31-38	SR-SICL-SL	CL	A-6, A-7	0-5	95-100	90-100	85-95	60-90	25-45	10-25
38-60	SR-SL-SICL	SM-SC, SC, CL, CL-ML	A-2, A-4, A-6	0-5	90-100	80-100	50-100	30-85	20-35	7-20

DEPTH (IN.)	CLAY (PCT)	MOIST BULK DENSITY (G/CM3)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SHRINK-SWELL POTENTIAL	EROSION FACTORS K	T	WIND EROD. GROUP	ORGANIC MATTER (PCT)	CORROSIVITY STEEL	CONCRETE
0-13	27-35	1.10-1.30	0.6-2.0	0.21-0.23	6.1-7.8	-	MODERATE	.28	5	7	5-6	HIGH	LOW
0-13	27-35	1.20-1.35	0.6-2.0	0.18-0.20	6.1-7.8	-	MODERATE	.28	5	6	5-6		
0-13	18-27	1.15-1.35	0.6-2.0	0.22-0.24	6.1-7.8	-	MODERATE	.28	5	6	5-6		
13-31	27-35	1.20-1.45	0.6-2.0	0.21-0.24	6.6-7.8	-	MODERATE	.28					
31-38	15-30	1.35-1.60	0.6-2.0	0.15-0.20	7.4-8.4	-	MODERATE	.28					
38-60	15-33	1.45-1.70	0.6-2.0	0.11-0.22	7.4-8.4	-	LOW	.28					

FLOODING FREQUENCY	DURATION	MONTHS	HIGH WATER TABLE DEPTH (FT)	KIND	MONTHS	CEMENTED PAN DEPTH (IN)	HARDNESS	BEDROCK DEPTH (IN)	HARDNESS	SUBSIDENCE INIT. (IN)	TOTAL (IN)	HYD GRP	POTENTIAL FROST ACTION
NONE			+.5-2.0	APPARENT	DEC-JUN	-		>60		-		B/D	HIGH

SANITARY FACILITIES		CONSTRUCTION MATERIAL	
SEPTIC TANK ABSORPTION FIELDS	SEVERE-PONDING	ROADFILL	POOR-WETNESS
SEWAGE LAGOON AREAS	SEVERE-PONDING	SAND	IMPROBABLE-EXCESS FINES
SANITARY LANDFILL (TRENCH)	SEVERE-PONDING	GRAVEL	IMPROBABLE-EXCESS FINES
SANITARY LANDFILL (AREA)	SEVERE-PONDING	TOPSOIL	POOR-WETNESS
DAILY COVER FOR LANDFILL	POOR-PONDING		

BUILDING SITE DEVELOPMENT		WATER MANAGEMENT	
		POND RESERVOIR AREA	MODERATE-SEEPAGE
SHALLOW EXCAVATIONS	SEVERE-PONDING	EMBANKMENTS DIKES AND LEVEES	SEVERE-PIPING, PONDING
DWELLINGS WITHOUT BASEMENTS	SEVERE-PONDING	EXCAVATED PONDS AQUIFER FED	MODERATE-SLOW REFILL
DWELLINGS WITH BASEMENTS	SEVERE-PONDING	DRAINAGE	PONDING, FROST ACTION
SMALL COMMERCIAL BUILDINGS	SEVERE-PONDING	IRRIGATION	PONDING
LOCAL ROADS AND STREETS	SEVERE-LOW STRENGTH, PONDING, FROST ACTION	TERRACES AND DIVERSIONS	PONDING
LAWNS, LANDSCAPING AND GOLF FAIRWAYS	SEVERE-PONDING	GRASSED WATERWAYS	WETNESS

REGIONAL INTERPRETATIONS

MI0042

SOIL INTERPRETATIONS RECORD

MLRA(S): 98, 99, 111, 97
REV. PGC,LWB, 9-87
TYPIC ARGIAQUOLLS, FINE, MIXED, MESIC

PEWAMO SERIES

THE PEWAMO SERIES CONSISTS OF POORLY DRAINED AND VERY POORLY DRAINED SOILS FORMED IN CLAYEY GLACIAL TILL OR LACUSTRINE SEDIMENTS ON TILL PLAINS, LAKE PLAINS AND MORAINES. THE SURFACE LAYER IS VERY DARK BROWN CLAY LOAM 13 INCHES THICK. THE SUBSOIL IS DARK GRAY AND GRAY MOTTLED SILTY CLAY 24 INCHES THICK. THE SUBSTRATUM IS GRAYISH BROWN MOTTLED SILTY CLAY LOAM. SLOPES ARE 0 TO 2 PERCENT. MOST AREAS ARE USED FOR CROPLAND.

ESTIMATED SOIL PROPERTIES

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT >3 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX
0-13	CL, MK-CL	CL	A-6, A-7	0-5	90-100	75-100	70-95	60-80	35-50	15-25
0-13	SICL, MK-SICL	CL	A-6, A-7	0-5	90-100	75-100	75-100	70-90	35-50	15-25
0-13	SIC, C	CH	A-7	0-5	90-100	75-100	75-100	75-95	50-55	25-30
13-37	CL, C, SIC	CL, CH	A-7	0-5	95-100	75-100	75-100	75-95	40-55	20-35
37-60	CL, SICL	CL	A-7	0-5	95-100	75-100	75-100	70-90	40-50	15-25

DEPTH (IN.)	CLAY (PCT)	MOIST BULK DENSITY (G/CM3)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SHRINK-SWELL POTENTIAL	EROSION FACTORS K	T	WIND EROD. GROUP	ORGANIC MATTER (PCT)	CORROSIVITY STEEL	CONCRETE
0-13	27-40	1.35-1.55	0.6-2.0	0.16-0.19	6.1-7.3	-	MODERATE	.24	5	6	3-12	HIGH	LOW
0-13	27-40	1.35-1.55	0.6-2.0	0.20-0.23	6.1-7.3	-	MODERATE	.28	5	7	3-12		
0-13	40-45	1.35-1.55	0.2-0.6	0.12-0.20	6.1-7.3	-	MODERATE	.28	5	4	3-5		
13-37	35-50	1.40-1.70	0.2-0.6	0.12-0.20	5.6-7.8	-	MODERATE	.32					
37-60	30-40	1.50-1.70	0.2-0.6	0.14-0.18	7.4-8.4	-	MODERATE	.37					

FLOODING FREQUENCY	DURATION	MONTHS	HIGH WATER TABLE DEPTH (FT)	KIND	MONTHS	CEMENTED PAN DEPTH (IN)	HARDNESS	BEDROCK DEPTH (IN)	HARDNESS	SUBSIDENCE INIT. (IN)	TOTAL (IN)	HYD GRP	POTENT'L FROST ACTION
NONE			+1-1.0	APPARENT	DEC-MAY	-		>60		-		C/D	HIGH

SANITARY FACILITIES

SEPTIC TANK ABSORPTION FIELDS	SEVERE-PONDING,PERCS SLOWLY
SEWAGE LAGOON AREAS	SEVERE-PONDING
SANITARY LANDFILL (TRENCH)	SEVERE-PONDING,TOO CLAYEY
SANITARY LANDFILL (AREA)	SEVERE-PONDING
DAILY COVER FOR LANDFILL	POOR-TOO CLAYEY,HARD TO PACK,PONDING

BUILDING SITE DEVELOPMENT

SHALLOW EXCAVATIONS	SEVERE-PONDING
DWELLINGS WITHOUT BASEMENTS	SEVERE-PONDING
DWELLINGS WITH BASEMENTS	SEVERE-PONDING
SMALL COMMERCIAL BUILDINGS	SEVERE-PONDING
LOCAL ROADS AND STREETS	SEVERE-LOW STRENGTH,PONDING,FROST ACTION
LAWNS, LANDSCAPING AND GOLF FAIRWAYS	CL,MK-CL,SICL,MK-SICL: SEVERE-PONDING SIC,C: SEVERE-PONDING,TOO CLAYEY

CONSTRUCTION MATERIAL

ROADFILL	POOR-LOW STRENGTH,WETNESS
SAND	IMPROBABLE-EXCESS FINES
GRAVEL	IMPROBABLE-EXCESS FINES
TOPSOIL	POOR-TOO CLAYEY,SMALL STONES,WETNESS

WATER MANAGEMENT

POND RESERVOIR AREA	SLIGHT
EMBANKMENTS DIKES AND LEVEES	SEVERE-PONDING
EXCAVATED PONDS AQUIFER FED	SEVERE-SLOW REFILL
DRAINAGE	PONDING,FROST ACTION
IRRIGATION	CL,MK-CL,SICL,MK-SICL: PONDING SIC,C: PONDING,SLOW INTAKE
TERRACES AND DIVERSIONS	ERODES EASILY,PONDING
GRASSED WATERWAYS	WETNESS,ERODES EASILY

REGIONAL INTERPRETATIONS

IN0015

SOIL INTERPRETATIONS RECORD

MLRA(S): 97, 98, 99, 111
REV. LBD, 10-87
TYPIC HAPLUDALFS, FINE-LOAMY, MIXED, MESIC

RIDDLES SERIES

THE RIDDLES SERIES CONSISTS OF DEEP, WELL DRAINED SOILS FORMED IN GLACIAL TILL ON TILL PLAINS AND MORAINES. THE SURFACE LAYER IS DARK BROWN FINE SANDY LOAM 8 INCHES THICK. THE SUBSOIL IS DARK YELLOWISH BROWN FINE SANDY LOAM IN UPPER 12 INCHES, BROWN SANDY CLAY LOAM IN NEXT 12 INCHES AND DARK YELLOWISH BROWN AND YELLOWISH BROWN LOAM IN LOWER 16 INCHES. THE SUBSTRATUM IS BROWN LOAM. SLOPES RANGE FROM 0 TO 35 PERCENT. CROPLAND IS THE DOMINANT USE.

ESTIMATED SOIL PROPERTIES

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT >3 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX
0-8	L, SIL	CL, ML, CL-ML	A-4	0-3	90-100	75-95	60-95	50-85	<25	NP-8
0-8	SL, FSL	SM, SM-SC	A-4	0-3	90-100	75-95	45-85	35-50	<25	NP-7
8-43	SCL, L, FSL	CL, SC	A-6	0-3	90-100	75-95	45-90	45-90	25-40	10-20
43-48	L, SL	CL-ML, CL, SM-SC, SC	A-4, A-6	0-3	90-100	75-95	45-90	45-90	25-35	5-15
48-60	SL, L	SM, SM-SC, CL-ML, ML	A-4	0-3	85-95	75-90	45-90	40-90	<20	NP-7

DEPTH (IN.)	CLAY (PCT)	MOIST BULK DENSITY (G/CM3)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SHRINK-SWELL POTENTIAL	EROSION FACTORS K	T	WIND EROD. GROUP	ORGANIC MATTER (PCT)	CORROSIVITY STEEL	CONCRETE
0-8	8-16	1.30-1.40	0.6-2.0	0.20-0.24	5.5-7.3	-	LOW	.32	5-4	5	.5-2	MODERATE	MODERATE
0-8	4-14	1.35-1.45	2.0-6.0	0.13-0.18	5.6-7.3	-	LOW	.24	5-4	3	.5-2		
8-43	18-30	1.40-1.60	0.6-2.0	0.12-0.18	4.5-7.3	-	MODERATE	.32					
43-48	15-22	1.40-1.60	0.6-2.0	0.11-0.19	6.6-7.8	-	LOW	.32					
48-60	3-15	1.45-1.65	0.6-2.0	0.08-0.13	7.4-8.4	-	LOW	.32					

FLOODING FREQUENCY	FLOODING DURATION	FLOODING MONTHS	HIGH WATER TABLE DEPTH (FT)	HIGH WATER TABLE KIND	HIGH WATER TABLE MONTHS	CEMENTED PAN DEPTH (IN)	CEMENTED PAN HARDNESS	BEDROCK DEPTH (IN)	BEDROCK HARDNESS	SUBSIDENCE INIT. (IN)	SUBSIDENCE TOTAL (IN)	HYD GRP	POTENTIAL FROST ACTION
NONE			>6.0			-		>60		-		B	MODERATE

SANITARY FACILITIES

SEPTIC TANK ABSORPTION FIELDS	0-8%: MODERATE-PERCS SLOWLY 8-15%: MODERATE-PERCS SLOWLY,SLOPE 15+%: SEVERE-SLOPE
SEWAGE LAGOON AREAS	0-2%: MODERATE-SEEPAGE 2-7%: MODERATE-SEEPAGE,SLOPE 7+%: SEVERE-SLOPE
SANITARY LANDFILL (TRENCH)	0-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE
SANITARY LANDFILL (AREA)	0-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE
DAILY COVER FOR LANDFILL	0-8%: FAIR-SMALL STONES 8-15%: FAIR-SMALL STONES,SLOPE 15+%: POOR-SLOPE

BUILDING SITE DEVELOPMENT

SHALLOW EXCAVATIONS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE
DWELLINGS WITHOUT BASEMENTS	0-8%: MODERATE-SHRINK-SWELL 8-15%: MODERATE-SHRINK-SWELL,SLOPE 15+%: SEVERE-SLOPE
DWELLINGS WITH BASEMENTS	0-8%: MODERATE-SHRINK-SWELL 8-15%: MODERATE-SLOPE,SHRINK-SWELL 15+%: SEVERE-SLOPE
SMALL COMMERCIAL BUILDINGS	0-4%: MODERATE-SHRINK-SWELL 4-8%: MODERATE-SHRINK-SWELL,SLOPE 8+%: SEVERE-SLOPE
LOCAL ROADS AND STREETS	0-8%: MODERATE-SHRINK-SWELL,LOW STRENGTH 8-15%: MODERATE-SHRINK-SWELL,LOW STRENGTH, SLOPE 15+%: SEVERE-SLOPE
LAWNS, LANDSCAPING AND GOLF FAIRWAYS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE

CONSTRUCTION MATERIAL

ROADFILL	0-15%: GOOD 15-25%: FAIR-SLOPE 25+%: POOR-SLOPE
SAND	IMPROBABLE-EXCESS FINES
GRAVEL	IMPROBABLE-EXCESS FINES
TOPSOIL	0-15%: POOR-SMALL STONES 15+%: POOR-SMALL STONES,SLOPE

WATER MANAGEMENT

POND RESERVOIR AREA	0-3%: MODERATE-SEEPAGE 3-8%: MODERATE-SEEPAGE,SLOPE 8+%: SEVERE-SLOPE
EMBANKMENTS DIKES AND LEVEES	MODERATE-THIN LAYER,PIPING
EXCAVATED PONDS AQUIFER FED	SEVERE-NO WATER
DRAINAGE	DEEP TO WATER
IRRIGATION	0-3% L,SIL: FAVORABLE 3+% L,SIL: SLOPE 0-3% SL,FSL: SOIL BLOWING 3+% SL,FSL: SLOPE,SOIL BLOWING
TERRACES AND DIVERSIONS	0-8% L,SIL: FAVORABLE 8+% L,SIL: SLOPE 0-8% SL,FSL: SOIL BLOWING 8+% SL,FSL: SLOPE,SOIL BLOWING
GRASSED WATERWAYS	0-8%: FAVORABLE 8+%: SLOPE

REGIONAL INTERPRETATIONS

SOIL INTERPRETATIONS RECORD

MLRA(S): 95A, 95B, 97, 98, 110, 111

REV. LWB, 9-87

SEBEWA SERIES

TYPIC ARGIAQUOLLS, FINE-LOAMY OVER SANDY OR SANDY-SKELETAL, MIXED, MESIC

THE SEBEWA SERIES CONSISTS OF POORLY AND VERY POORLY DRAINED SOILS FORMED IN LOAMY AND SANDY GLACIOFLUVIAL DEPOSITS ON OUTWASH PLAINS, VALLEY TRAINS AND TERRACES. THE SURFACE SOIL IS VERY DARK GRAY AND DARK GRAY LOAM 14 INCHES THICK. THE SUBSOIL IS GRAY MOTTLED SANDY CLAY LOAM, CLAY LOAM AND GRAVELLY CLAY LOAM 22 INCHES THICK. THE SUBSTRATUM IS GRAY GRAVELLY SAND. SLOPES ARE 0 TO 3 PERCENT. MOST AREAS ARE USED FOR CROPLAND.

ESTIMATED SOIL PROPERTIES

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT >3 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX
0-14	L, MK-L	CL, CL-ML	A-4, A-6	0	95-100	75-100	65-95	50-75	20-35	4-15
0-14	SL	SM, SC, SM-SC	A-2, A-4	0	95-100	75-100	45-70	25-45	<30	NP-10
0-14	SIL	CL, CL-ML	A-6, A-4	0	95-100	75-100	70-90	50-90	20-35	5-15
14-36	SCL, L, GR-CL	SC, CL	A-6, A-7, A-2	0	95-100	60-90	50-90	25-75	25-45	10-25
36-60	GR-S, GRV-S, S	SP, SP-SM, GP, GP-GM	A-1, A-3, A-2	0-5	40-75	25-75	20-55	0-10	-	NP

DEPTH (IN.)	CLAY (PCT)	MOIST BULK DENSITY (G/CM3)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SHRINK-SWELL POTENTIAL	EROSION FACTORS K	T	WIND EROD. GROUP	ORGANIC MATTER (PCT)	CORROSIVITY STEEL	CONCRETE
0-14	10-25	1.10-1.50	0.5-2.0	0.18-0.25	6.1-7.8	-	LOW	.24	4	5	2-12	HIGH	LOW
0-14	5-20	1.15-1.60	0.6-2.0	0.12-0.15	6.1-7.8	-	LOW	.20	4	3	2-8		
0-14	12-25	1.15-1.60	0.6-2.0	0.22-0.24	6.1-7.8	-	LOW	.28	4	5	2-8		
14-36	18-35	1.50-1.80	0.6-2.0	0.15-0.19	6.1-7.8	-	MODERATE	.32					
36-60	0-3	1.55-1.75	>6.0	0.02-0.04	7.4-8.4	-	LOW	.10					

FLOODING FREQUENCY	DURATION	MONTHS	HIGH WATER TABLE DEPTH (FT)	KIND	MONTHS	CEMENTED PAN DEPTH (IN)	HARDNESS	BEDROCK DEPTH (IN)	HARDNESS	SUBSIDENCE INIT. (IN)	TOTAL (IN)	HYD GRP	POTENT'L FROST ACTION
NONE			+1-1.0	APPARENT	SEP-MAY	-		>60		-		B/D	HIGH

SANITARY FACILITIES

SEPTIC TANK ABSORPTION FIELDS	SEVERE-PONDING,POOR FILTER
SEWAGE LAGOON AREAS	SEVERE-SEEPAGE,PONDING
SANITARY LANDFILL (TRENCH)	SEVERE-SEEPAGE,PONDING,TOO SANDY
SANITARY LANDFILL (AREA)	SEVERE-SEEPAGE,PONDING
DAILY COVER FOR LANDFILL	POOR-SEEPAGE,TOO SANDY,SMALL STONES

BUILDING SITE DEVELOPMENT

SHALLOW EXCAVATIONS	SEVERE-CUTBANKS CAVE,PONDING
DWELLINGS WITHOUT BASEMENTS	SEVERE-PONDING
DWELLINGS WITH BASEMENTS	SEVERE-PONDING
SMALL COMMERCIAL BUILDINGS	SEVERE-PONDING
LOCAL ROADS AND STREETS	SEVERE-PONDING,FROST ACTION
LAWNS, LANDSCAPING AND GOLF FAIRWAYS	SEVERE-PONDING

CONSTRUCTION MATERIAL

ROADFILL	POOR-WETNESS
SAND	PROBABLE
GRAVEL	PROBABLE
TOPSOIL	POOR-SMALL STONES,AREA RECLAIM,WETNESS

WATER MANAGEMENT

POND RESERVOIR AREA	SEVERE-SEEPAGE
EMBANKMENTS DIKES AND LEVEES	SEVERE-SEEPAGE,PONDING
EXCAVATED PONDS AQUIFER FED	SEVERE-CUTBANKS CAVE
DRAINAGE	PONDING,FROST ACTION,CUTBANKS CAVE
IRRIGATION	L, MK-L, SIL: PONDING,ROOTING DEPTH SL: PONDING,SOIL BLOWING,ROOTING DEPTH
TERRACES AND DIVERSIONS	L, MK-L, SIL: PONDING,TOO SANDY SL: PONDING,TOO SANDY,SOIL BLOWING
GRASSED WATERWAYS	WETNESS,ROOTING DEPTH

REGIONAL INTERPRETATIONS

MI0240 SOIL INTERPRETATIONS RECORD

MLRA(S): 110, 95B, 98
REV. FLA,LWB, 12-87
TYPIC ARGIAQUOLLS, FINE-LOAMY OVER SANDY OR SANDY-SKELETAL, MIXED, MESIC

SEBEWA SERIES
CLAY SUBSTRATUM

THE SEBEWA SERIES, CLAY SUBSTRATUM, CONSISTS OF POORLY DRAINED SOILS FORMED IN LOAMY OVER SANDY AND CLAYEY SEDIMENTS IN OLD LAKE BASINS. THE SURFACE LAYER IS VERY DARK BROWN SILT LOAM 10 INCHES THICK. THE SUBSOIL IS DARK GRAYISH BROWN MOTTLED FINE SANDY LOAM IN UPPER 4 INCHES, BROWNISH GRAY MOTTLED LOAM IN NEXT 5 INCHES, AND LIGHT BROWNISH GRAY MOTTLED SANDY CLAY LOAM IN LOWER 3 INCHES. THE SUBSTRATUM IS 20 INCHES OF GRAYISH BROWN SAND AND GRAVEL OVER LIGHT GRAY AND PINKISH GRAY CLAY AND SILT. SLOPES ARE 0 TO 2 PERCENT. AREAS ARE USED FOR PASTURELAND AND CROPLAND.

ESTIMATED SOIL PROPERTIES

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT >3 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX
0-10	SIL, L	CL-ML, CL	A-4, A-6	0	90-100	75-100	70-95	50-90	20-35	4-15
0-10	SL, FSL	SM, ML, SC, CL	A-2, A-4, A-1	0	90-100	75-100	45-85	20-55	<30	NP-10
10-27	L, GR-CL, SICL	CL, SC	A-6, A-7, A-2	0	95-100	60-90	50-90	25-85	25-45	10-25
27-42	SG	SP, SP-SM, GP, GP-GM	A-1	0-5	40-75	35-70	20-40	0-10	-	NP
42-60	SR-SI-C	CH, MH	A-7	0	100	100	95-100	85-100	50-65	20-35

DEPTH (IN.)	CLAY (PCT)	MOIST BULK DENSITY (G/CM3)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SHRINK-SWELL POTENTIAL	EROSION FACTORS K	T	WIND EROD. GROUP	ORGANIC MATTER (PCT)	CORROSIVITY STEEL	CONCRETE
0-10	10-25	1.15-1.50	0.6-2.0	0.22-0.24	6.5-7.3	-	LOW	.24	4	5	1-4	HIGH	LOW
0-10	5-20	1.15-1.60	2.0-6.0	0.12-0.14	6.6-7.3	-	LOW	.20	4	3	1-4		
10-27	18-35	1.50-1.70	0.6-2.0	0.15-0.19	6.6-7.8	-	MODERATE	.32					
27-42	0-5	1.55-1.70	6.0-20	0.03-0.05	7.9-8.4	-	LOW	.10					
42-60	35-60	1.35-1.70	<0.06	0.10-0.16	7.9-8.4	-	MODERATE	.32					

FLOODING FREQUENCY	FLOODING DURATION	FLOODING MONTHS	HIGH WATER TABLE DEPTH (FT)	HIGH WATER TABLE KIND	HIGH WATER TABLE MONTHS	CEMENTED PAN DEPTH (IN)	CEMENTED PAN HARDNESS	BEDROCK DEPTH (IN)	BEDROCK HARDNESS	SUBSIDENCE INIT. (IN)	SUBSIDENCE TOTAL (IN)	HYD GRP	POTENTIAL FROST ACTION
NONE			+1-1.0	APPARENT	SEP-MAY	-		>60		-		B/D	HIGH

SANITARY FACILITIES

SEPTIC TANK ABSORPTION FIELDS	SEVERE-PONDING,PERCS SLOWLY,POOR FILTER
SEWAGE LAGOON AREAS	SEVERE-SEEPAGE,PONDING
SANITARY LANDFILL (TRENCH)	SEVERE-PONDING,TOO CLAYEY
SANITARY LANDFILL (AREA)	SEVERE-SEEPAGE,PONDING
DAILY COVER FOR LANDFILL	POOR-TOO CLAYEY,HARD TO PACK,PONDING

BUILDING SITE DEVELOPMENT

SHALLOW EXCAVATIONS	SEVERE-CUTBANKS CAVE,PONDING
DWELLINGS WITHOUT BASEMENTS	SEVERE-PONDING
DWELLINGS WITH BASEMENTS	SEVERE-PONDING
SMALL COMMERCIAL BUILDINGS	SEVERE-PONDING
LOCAL ROADS AND STREETS	SEVERE-PONDING,FROST ACTION
LAWNS, LANDSCAPING AND GOLF FAIRWAYS	SEVERE-PONDING

REGIONAL INTERPRETATIONS

CONSTRUCTION MATERIAL

ROADFILL	POOR-LOW STRENGTH,WETNESS
SAND	IMPROBABLE-EXCESS FINES
GRAVEL	IMPROBABLE-EXCESS FINES
TOPSOIL	POOR-SMALL STONES,WETNESS

WATER MANAGEMENT

POND RESERVOIR AREA	SEVERE-SEEPAGE
EMBANKMENTS DIKES AND LEVEES	SEVERE-PONDING
EXCAVATED PONDS AQUIFER FED	SEVERE-SLOW REFILL
DRAINAGE	PONDING,FROST ACTION
IRRIGATION	SIL,L: PONDING,PERCS SLOWLY SL,FSL: PONDING,SOIL BLOWING,PERCS SLOWLY
TERRACES AND DIVERSIONS	SIL,L: PONDING,PERCS SLOWLY SL,FSL: PONDING,SOIL BLOWING,PERCS SLOWLY
GRASSED WATERWAYS	WETNESS

SOIL INTERPRETATIONS RECORD

SLEETH SERIES

MLRA(S): 98, 111, 114, 115
REV. LBD, 2-85
AERIC OCHRAQUALFS, FINE-LOAMY, MIXED, MESIC

THE SLEETH SERIES CONSISTS OF DEEP, SOMEWHAT POORLY DRAINED SOILS FORMED IN OUTWASH SEDIMENTS ON UPLANDS. THE SURFACE LAYER IS DARK GRAYISH BROWN LOAM 8 INCHES THICK. THE SUBSURFACE LAYER IS GRAYISH BROWN MOTTLED LOAM 3 INCHES THICK. THE SUBSOIL IS BROWN, GRAYISH BROWN AND DARK GRAY MOTTLED CLAY LOAM IN UPPER 21 INCHES AND DARK GRAY AND GRAYISH BROWN MOTTLED GRAVELLY CLAY LOAM IN LOWER 16 INCHES. THE SUBSTRATUM IS GRAYISH BROWN GRAVELLY SAND AND SAND. SLOPES ARE 0 TO 2 PERCENT. MOST AREAS ARE USED FOR CROPLAND.

ESTIMATED SOIL PROPERTIES

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT >3 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX
0-11	L, SIL	CL, ML, CL-ML	A-4, A-6	0	100	90-100	75-95	50-85	20-35	3-15
0-11	SL	SM, SC, SM-SC	A-2-4, A-4	0	90-100	85-100	60-70	30-40	20-30	3-10
11-32	CL, SICL, SCL	CL	A-6	0	85-95	85-95	80-90	65-75	30-40	15-25
32-48	GR-CL, GR-SCL, GR-L	CL	A-6	0-3	65-95	60-85	55-70	50-70	30-40	15-25
48-60	SR-S-GR-S	SP, GP, SP-SM, GP-GM	A-1	1-5	30-70	22-55	7-20	2-10	-	NP

DEPTH (IN.)	CLAY (PCT)	MOIST BULK DENSITY (G/CM3)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SHRINK-SWELL POTENTIAL	EROSION FACTORS K	T	WIND EROD. GROUP	ORGANIC MATTER (PCT)	CORROSIVITY STEEL	CONCRETE
0-11	11-22	1.30-1.45	0.6-2.0	0.20-0.24	6.6-7.3	-	LOW	.32	5	5	.5-3	HIGH	LOW
0-11	10-20	1.30-1.45	0.6-2.0	0.13-0.15	6.6-7.3	-	LOW	.32	5	3	.5-3		
11-32	20-35	1.45-1.60	0.6-2.0	0.15-0.19	5.6-6.5	-	MODERATE	.32					
32-48	20-35	1.40-1.60	0.6-2.0	0.14-0.16	6.6-8.4	-	MODERATE	.32					
48-60	2-5	1.60-1.80	>20	0.02-0.04	7.9-8.4	-	LOW	.10					

FLOODING FREQUENCY	DURATION	MONTHS	HIGH WATER TABLE DEPTH (FT)	KIND	MONTHS	CEMENTED PAN DEPTH (IN)	HARDNESS	BEDROCK DEPTH (IN)	HARDNESS	SUBSIDENCE INIT. (IN)	TOTAL (IN)	HYD GRP	POTENT'L FROST ACTION
NONE			1.0-3.0	APPARENT	JAN-APR	-		>60		-		C	HIGH

SANITARY FACILITIES

SEPTIC TANK ABSORPTION FIELDS	SEVERE-WETNESS
SEWAGE LAGOON AREAS	SEVERE-SEEPAGE,WETNESS
SANITARY LANDFILL (TRENCH)	SEVERE-SEEPAGE,WETNESS
SANITARY LANDFILL (AREA)	SEVERE-WETNESS
DAILY COVER FOR LANDFILL	POOR-WETNESS

BUILDING SITE DEVELOPMENT

SHALLOW EXCAVATIONS	SEVERE-CUTBANKS CAVE,WETNESS
DWELLINGS WITHOUT BASEMENTS	SEVERE-WETNESS
DWELLINGS WITH BASEMENTS	SEVERE-WETNESS
SMALL COMMERCIAL BUILDINGS	SEVERE-WETNESS
LOCAL ROADS AND STREETS	SEVERE-LOW STRENGTH,FROST ACTION
LAWNS, LANDSCAPING AND GOLF FAIRWAYS	MODERATE-WETNESS

CONSTRUCTION MATERIAL

ROADFILL	FAIR-WETNESS
SAND	PROBABLE
GRAVEL	PROBABLE
TOPSOIL	POOR-AREA RECLAIM

WATER MANAGEMENT

POND RESERVOIR AREA	SEVERE-SEEPAGE
EMBANKMENTS DIKES AND LEVEES	SEVERE-WETNESS
EXCAVATED PONDS AQUIFER FED	SEVERE-CUTBANKS CAVE
DRAINAGE	FROST ACTION
IRRIGATION	L,SIL: WETNESS SL: WETNESS,SOIL BLOWING
TERRACES AND DIVERSIONS	L,SIL: WETNESS SL: WETNESS,SOIL BLOWING
GRASSED WATERWAYS	WETNESS

REGIONAL INTERPRETATIONS

MLRA(S): 95B, 97, 98, 99, 111
REV. LWB, 8-89
PSAMMENTIC HAPLUDALFS, SANDY, MIXED, MESIC

THE SPINKS SERIES CONSISTS OF WELL DRAINED SOILS FORMED IN GLACIOFLUVIAL DEPOSITS ON MORAINES, TILL PLAINS, OUTWASH PLAINS AND BEACH RIDGES. THE SURFACE LAYER IS DARK GRAYISH BROWN LOAMY SAND 10 INCHES THICK. THE SUBSURFACE LAYER IS YELLOWISH BROWN LOAMY SAND 12 INCHES THICK. THE NEXT 63 INCHES IS PALE BROWN SAND WITH LAMELLA AND BANDS OF DARK BROWN LOAMY FINE SAND. THE SUBSTRATUM IS YELLOWISH BROWN FINE SAND. SLOPES RANGE FROM 0 TO 60 PERCENT. AREAS ARE USED FOR CROPLAND, HAYLAND, PASTURELAND AND WOODLAND.

LANDSCAPE AND CLIMATE PROPERTIES

ANNUAL AIR TEMPERATURE	FROST FREE DAYS	ANNUAL PRECIPITATION	ELEVATION (FT)	DRAINAGE CLASS	SLOPE (PCT)
47-50	130-170	29-37	600-1200	W	0-45

ESTIMATED SOIL PROPERTIES

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT. >10 IN (PCT)	FRACT. 3-10 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	CLAY (PCT)
0-10	LS, LFS	SM, SM-SC, SP-SM	A-2-4, A-1-B	0	0	95-100	80-100	35-90	10-30	2-15
0-10	S, FS	SP-SM, SM	A-2-4, A-3, A-1-B	0	0	95-100	80-100	35-70	5-35	0-10
10-22	LS, S, LFS	SM, SP-SM, SM-SC	A-2-4, A-3, A-1-B	0	0	95-100	80-100	35-90	5-35	0-15
22-85	FS, LFS, S	SM, SP-SM, SM-SC	A-2-4, A-1-B	0	0	95-100	80-100	40-90	10-35	3-15
85-99	FS, S	SP-SM, SM	A-2-4, A-3, A-1-B	0	0	95-100	80-100	35-90	5-35	0-10

DEPTH (IN.)	LIQUID LIMIT	PLASTICITY INDEX	MOIST BULK DENSITY (G/CM3)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SAR	CEC (ME/100G)	CACO3 (PCT)	GYPSUM (PCT)
0-10	<25	NP-7	1.40-1.70	6.0-20	0.08-0.10	5.1-7.3	-	-	3-20	-	-
0-10	<20	NP-4	1.40-1.70	6.0-20	0.06-0.08	5.1-7.3	-	-	2-5	-	-
10-22	<25	NP-7	1.40-1.70	2.0-20	0.05-0.10	5.6-7.3	-	-	1-4	-	-
22-85	<25	NP-7	1.40-1.70	2.0-6.0	0.04-0.08	5.6-7.8	-	-	1-6	-	-
85-99	<20	NP-4	1.40-1.70	6.0-20	0.04-0.06	6.6-8.4	-	-	0-2	-	-

DEPTH (IN.)	ORGANIC MATTER (PCT)	SHRINK-SWELL POTENTIAL	EROSION FACTORS K	T	WIND EROD. GROUP	WIND EROD. INDEX	CORROSIVITY STEEL	CONCRETE
0-10	2-4	LOW	.17	5	2	134	LOW	LOW
0-10	2-4	LOW	.15	5	1	220		
10-22	-	LOW	.17					
22-85	-	LOW	.17					
85-99	-	LOW	.17					

FLOODING FREQUENCY	DURATION	MONTHS	HIGH WATER TABLE DEPTH (FT)	KIND	MONTHS	CEMENTED PAN DEPTH (IN)	HARDNESS	BEDROCK DEPTH (IN)	HARDNESS	SUBSIDENCE INIT. (IN)	TOTAL (IN)	HYD GRP	POTENT'L FROST ACTION
NONE			>6.0			-		>60		-		A	LOW

SANITARY FACILITIES

SEPTIC TANK ABSORPTION FIELDS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE
SEWAGE LAGOON AREAS	0-7%: SEVERE-SEEPAGE 7+%: SEVERE-SEEPAGE,SLOPE
SANITARY LANDFILL (TRENCH)	0-15%: SEVERE-SEEPAGE,TOO SANDY 15+%: SEVERE-SEEPAGE,SLOPE,TOO SANDY
SANITARY LANDFILL (AREA)	0-15%: SEVERE-SEEPAGE 15+%: SEVERE-SEEPAGE,SLOPE
DAILY COVER FOR LANDFILL	0-15%: POOR-SEEPAGE,TOO SANDY 15+%: POOR-SEEPAGE,TOO SANDY,SLOPE

BUILDING SITE DEVELOPMENT

SHALLOW EXCAVATIONS	0-15%: SEVERE-CUTBANKS CAVE 15+%: SEVERE-CUTBANKS CAVE,SLOPE
DWELLINGS WITHOUT BASEMENTS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE
DWELLINGS WITH BASEMENTS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE
SMALL COMMERCIAL BUILDINGS	0-4%: SLIGHT 4-8%: MODERATE-SLOPE 8+%: SEVERE-SLOPE
LOCAL ROADS AND STREETS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE
LAWNS LANDSCAPING AND GOLF FAIRWAYS	0-8% LS,LFS: MODERATE-DROUGHTY 8-15% LS,LFS: MODERATE-DROUGHTY,SLOPE 15+% LS,LFS: SEVERE-SLOPE 0-15% S,FS: SEVERE-DROUGHTY 15+% S,FS: SEVERE-DROUGHTY,SLOPE

CONSTRUCTION MATERIAL

ROADFILL	0-15%: GOOD 15-25%: FAIR-SLOPE 25+%: POOR-SLOPE
SAND	PROBABLE
GRAVEL	IMPROBABLE-TOO SANDY
TOPSOIL	0-8% LS,LFS: FAIR-TOO SANDY 8-15% LS,LFS: FAIR-SLOPE,TOO SANDY 15+% LS,LFS: POOR-SLOPE 0-15% S,FS: POOR-TOO SANDY 15+% S,FS: POOR-SLOPE,TOO SANDY

WATER MANAGEMENT

POND RESERVOIR AREA	0-8%: SEVERE-SEEPAGE 8+%: SEVERE-SEEPAGE,SLOPE
EMBANKMENTS DIKES AND LEVEES	SEVERE-SEEPAGE,PIPING
EXCAVATED PONDS AQUIFER FED	SEVERE-NO WATER
DRAINAGE	DEEP TO WATER
IRRIGATION	0-3%: DROUGHTY,FAST INTAKE 3+%: SLOPE,DROUGHTY,FAST INTAKE
TERRACES AND DIVERSIONS	0-8%: TOO SANDY,SOIL BLOWING 8+%: SLOPE,TOO SANDY,SOIL BLOWING
GRASSED WATERWAYS	0-8%: DROUGHTY 8+%: SLOPE,DROUGHTY

MI0018 SOIL INTERPRETATIONS RECORD

MLRA(S): 97, 98, 99, 111 TEASDALE SERIES
REV. LWB, 7-87
GLOSSAQUIC HAPLUDALFS, COARSE-LOAMY, SILICEOUS, MESIC

THE TEASDALE SERIES CONSISTS OF SOMEWHAT POORLY DRAINED SOILS FORMED IN SANDY LOAM GLACIAL TILL ON UPLANDS. THE SURFACE LAYER IS DARK BROWN FINE SANDY LOAM 9 INCHES THICK. THE SUBSURFACE LAYER IS YELLOWISH BROWN FINE SANDY LOAM 4 INCHES THICK. THE NEXT 11 INCHES IS YELLOWISH BROWN FINE SANDY LOAM INTERFINGERED WITH BROWN FINE SANDY LOAM. THE SUBSOIL IS DARK BROWN MOTTLED SANDY CLAY LOAM, 31 INCHES THICK. THE SUBSTRATUM IS YELLOWISH BROWN SANDY LOAM. SLOPES RANGE FROM 0 TO 4 PERCENT. MOST AREAS ARE USED FOR CROPLAND.

ESTIMATED SOIL PROPERTIES (A)

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT >3 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX
0-13	FSL, SL	SM, SC, ML, CL	A-2-4, A-4	0-5	90-100	85-100	50-85	25-55	<25	2-8
0-13	L	ML, CL, CL-ML	A-4	0-5	90-100	85-100	70-95	50-75	<25	2-8
13-55	SL, FSL, GR-L	CL, SC, CL-ML, SM-SC	A-2-6, A-6, A-2-4, A-4	0-15	85-100	70-100	40-80	25-75	20-30	5-15
55-65	SL, LS, FSL	SM, SM-SC, SC, ML	A-2-4, A-4, A-1-B	0-15	85-100	70-100	35-80	15-55	<25	NP-8

DEPTH (IN.)	CLAY (PCT)	MOIST BULK DENSITY (G/CM3)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SHRINK-SWELL POTENTIAL	EROSION FACTORS K	T	WIND EROD. GROUP	ORGANIC MATTER (PCT)	CORROSIVITY STEEL	CONCRETE
0-13	5-15	1.25-1.75	2.0-6.0	0.12-0.15	5.1-6.5	-	LOW	.24	5	3	2-3	MODERATE	MODERATE
0-13	8-15	1.25-1.75	0.6-2.0	0.16-0.18	5.1-6.5	-	LOW	.32	5	5	2-3		
13-55	10-18	1.55-1.75	0.6-2.0	0.11-0.17	4.5-7.3	-	LOW	.24					
55-65	5-15	1.60-1.85	2.0-6.0	0.08-0.15	6.6-8.4	-	LOW	.24					

FLOODING FREQUENCY	DURATION	MONTHS	HIGH WATER TABLE DEPTH (FT)	KIND	MONTHS	CEMENTED PAN DEPTH (IN)	HARDNESS	BEDROCK DEPTH (IN)	HARDNESS	SUBSIDENCE INIT. (IN)	TOTAL (IN)	HYD GRP	POTENT'L FROST ACTION
NONE			1.0-2.0	APPARENT	NOV-MAY	-		>60		-		B	HIGH

SANITARY FACILITIES

SEPTIC TANK ABSORPTION FIELDS	SEVERE-WETNESS
SEWAGE LAGOON AREAS	SEVERE-SEEPAGE, WETNESS
SANITARY LANDFILL (TRENCH)	SEVERE-SEEPAGE, WETNESS
SANITARY LANDFILL (AREA)	SEVERE-WETNESS
DAILY COVER FOR LANDFILL	POOR-WETNESS

BUILDING SITE DEVELOPMENT

SHALLOW EXCAVATIONS	SEVERE-CUTBANKS CAVE, WETNESS
DWELLINGS WITHOUT BASEMENTS	SEVERE-WETNESS
DWELLINGS WITH BASEMENTS	SEVERE-WETNESS
SMALL COMMERCIAL BUILDINGS	SEVERE-WETNESS
LOCAL ROADS AND STREETS	SEVERE-FROST ACTION
LAWNS, LANDSCAPING AND GOLF FAIRWAYS	MODERATE-WETNESS

REGIONAL INTERPRETATIONS

CONSTRUCTION MATERIAL

ROADFILL	FAIR-WETNESS
SAND	IMPROBABLE-EXCESS FINES
GRAVEL	IMPROBABLE-EXCESS FINES
TOPSOIL	POOR-SMALL STONES

WATER MANAGEMENT

POND RESERVOIR AREA	SEVERE-SEEPAGE
EMBANKMENTS DIKES AND LEVEES	SEVERE-WETNESS
EXCAVATED PONDS AQUIFER FED	SEVERE-CUTBANKS CAVE
DRAINAGE	0-3%: FROST ACTION 3+%: FROST ACTION, SLOPE
IRRIGATION	0-3% L: WETNESS 3+% L: SLOPE, WETNESS 0-3% FSL, SL: WETNESS, SOIL BLOWING 3+% FSL, SL: SLOPE, WETNESS, SOIL BLOWING
TERRACES AND DIVERSIONS	L: WETNESS FSL, SL: WETNESS, SOIL BLOWING
GRASSED WATERWAYS	WETNESS, ROOTING DEPTH

NY0053

SOIL INTERPRETATIONS RECORD

MLRA(S): 95B, 101, 111, 139, 140, 144A
REV. HEW,JWW, 4-83
TH..TO-HISTIC FLUVAQUENTS, FINE-LOAMY, MIXED, NONACID, MESIC

WALLKILL SERIE
UPLAN

LLKILL SERIES CONSISTS OF DEEP, VERY POORLY DRAINED SOILS ON THE MARGINS OF ORGANIC SOILS ON THE UPLANDS. THEY ..D IN ALLUVIUM OVER ORGANIC MATERIAL. TYPICALLY, THE SURFACE LAYER IS VERY DARK BROWN SILT LOAM 8 INCHES THICK. THE SUBSOIL FROM 8 TO 24 INCHES IS GRAYISH BROWN MOTTLED SILT LOAM. THE SUBSTRATUM FROM 24 TO 60 INCHES IS BLACK AND VERY DARK GRAYISH-BROWN ORGANIC MATERIAL CONTAINING 40 TO 60 PERCENT FIBER WHEN BROKEN. SLOPES RANGE FROM 0 TO 3 PERCENT.

ESTIMATED SOIL PROPERTIES (A)

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT >3 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX
0-8	SIL, L, FSL	ML, SM, CL	A-5, A-7	0	95-100	90-100	70-100	40-90	40-50	5-15
0-8	SICL			0	95-100	90-100	85-100	75-95	30-36	12-15
8-24	SIL, L, GR-SIL	CL, CL-ML, SM-SC, SC	A-4	0	75-100	70-100	60-100	40-90	15-25	5-10
24-60	SP, HM	PT	A-8	0	-	-	-	-	-	-

DEPTH (IN.)	CLAY (PCT)	MOIST BULK DENSITY (G/CM3)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SHRINK-SWELL POTENTIAL	EROSION FACTORS K	T	WIND EROD. GROUP	ORGANIC MATTER (PCT)	CORROSIVITY STEEL	CONCRETE
0-8	10-27	1.15-1.40	0.6-2.0	0.16-0.21	5.1-7.8	-	LOW	.37	5	-	4-12	MODERATE	MODERATE
0-8	27-32	1.25-1.45	0.6-2.0	0.21-0.23	5.1-7.8	-	LOW	.37	5	3	3-10		
8-24	15-27	1.15-1.45	0.6-2.0	0.15-0.20	5.1-7.8	-	LOW	.37					
24-60	-	0.25-0.45	2.0-20	0.35-0.45	5.6-7.8	-							

FLOODING FREQUENCY	DURATION	MONTHS	HIGH WATER TABLE DEPTH (FT)	KIND	MONTHS	CEMENTED PAN DEPTH (IN)	HARDNESS	BEDROCK DEPTH (IN)	HARDNESS	SUBSIDENCE INIT. (IN)	TOTAL (IN)	HYD GRP	POTENT'L FROST ACTION
NONE			+.5-1.0	APPARENT	SEP-JUN	-		>60		-		C/D	HIGH

SANITARY FACILITIES (B)

SEPTIC TANK ABSORPTION FIELDS	SEVERE-FLOODING,WETNESS,POOR FILTER
SEWAGE LAGOON AREAS	SEVERE-SEEPAGE,FLOODING,EXCESS HUMUS
SANITARY LANDFILL (TRENCH)	SEVERE-FLOODING,SEEPAGE,WETNESS
SANITARY LANDFILL (AREA)	SEVERE-FLOODING,SEEPAGE,WETNESS
DAILY COVER FOR LANDFILL	POOR-WETNESS,EXCESS HUMUS

CONSTRUCTION MATERIAL (B)

ROADFILL	POOR-WETNESS
SAND	IMPROBABLE-EXCESS FINES
GRAVEL	IMPROBABLE-EXCESS FINES
TOPSOIL	POOR-WETNESS

BUILDING SITE DEVELOPMENT (B)

SHALLOW EXCAVATIONS	SEVERE-EXCESS HUMUS,WETNESS
DWELLINGS WITHOUT BASEMENTS	SEVERE-FLOODING,WETNESS,LOW STRENGTH
DWELLINGS WITH BASEMENTS	SEVERE-FLOODING,WETNESS,LOW STRENGTH
SMALL COMMERCIAL BUILDINGS	SEVERE-FLOODING,WETNESS,LOW STRENGTH
LOCAL ROADS AND STREETS	SEVERE-WETNESS,FLOODING,FROST ACTION
LAWNS, LANDSCAPING AND GOLF FAIRWAYS	SEVERE-WETNESS,FLOODING

WATER MANAGEMENT (B)

POND RESERVOIR AREA	SEVERE-SEEPAGE
EMBANKMENTS DIKES AND LEVEES	SEVERE-EXCESS HUMUS,WETNESS
EXCAVATED PONDS AQUIFER FED	MODERATE-SLOW REFILL
DRAINAGE	FLOODING,FROST ACTION
IRRIGATION	GR-SIL,GR-L,GR-FSL: WETNESS,FLOODING SIL,L,FSL: WETNESS,ERODES EASILY,FLOODING
TERRACES AND DIVERSIONS	ERODES EASILY,WETNESS
GRASSED WATERWAYS	WETNESS,ERODES EASILY

REGIONAL INTERPRETATIONS

HYDROGEOLOGIC ASSESSMENT: VOLUME II
GROUNDWATER MODELING
OF THE MCGRAW EDISON FACILITY
ALBION, MICHIGAN

June 27, 1986

Prepared By:

Fred C. Hart Associates, Inc.
530 Fifth Avenue
New York, NY 10036

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   - Recovery Test of Fire Well
   - Drawdown Test of Clark Street Well
   - Data Interpretation

6. Field Data for Shallow Aquifer Pump Test

1.0 Executive Summary

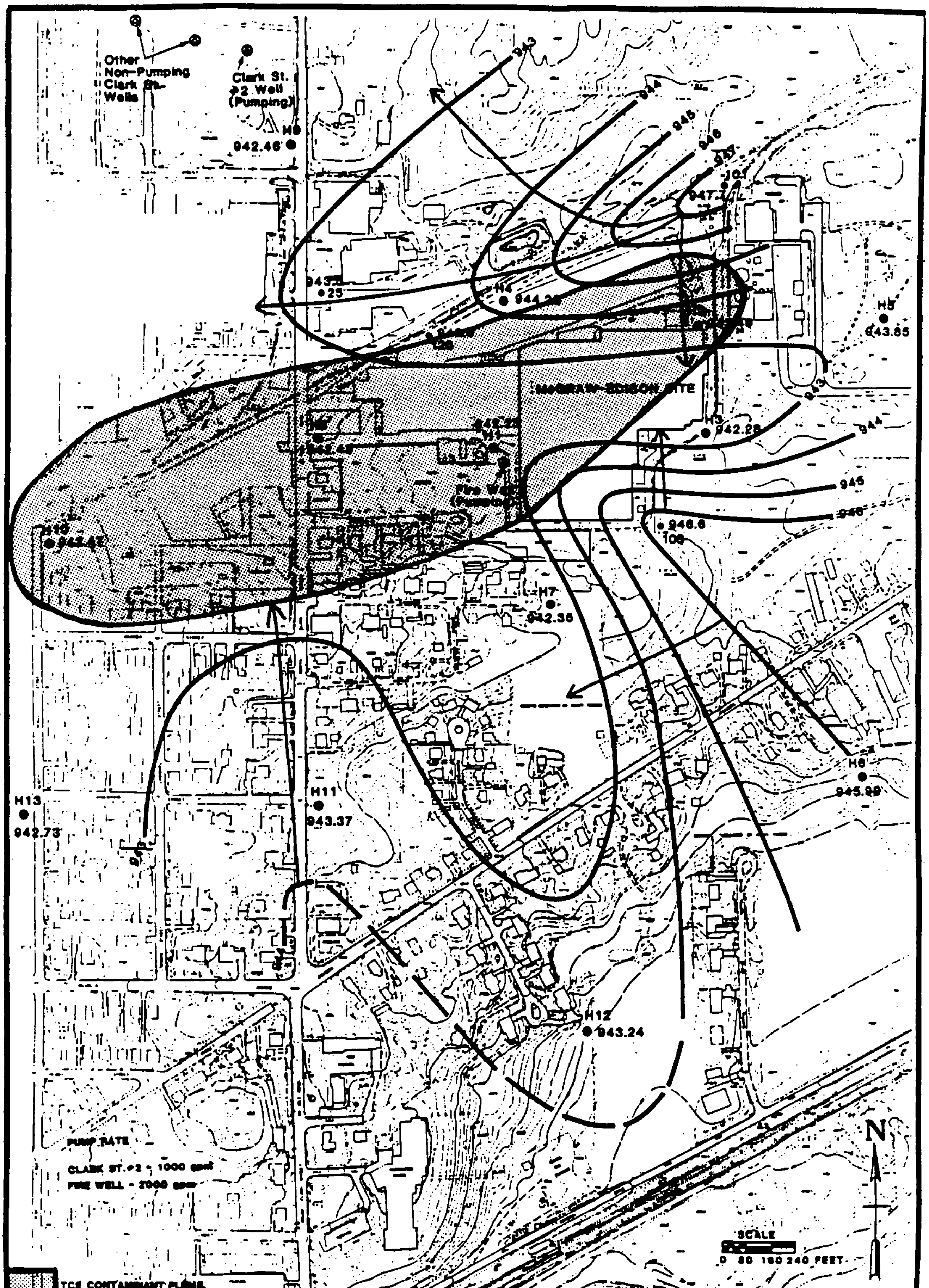
Fred C. Hart Associates, Inc. (HART) performed a comprehensive assessment of the McGraw-Edison site in Albion, Michigan on behalf of Cooper Industries and in accordance with the Stipulation and Order Regarding Hydrogeologic Study and Soil Contamination entered on June 14, 1985 with the state of Michigan. The conclusions of the assessment demonstrate that an effective remediation is possible. The conclusions are summarized as follows:

1. The hydrogeologic study has defined the vertical and horizontal extent of groundwater contamination and defined the direction and rate of movement of the groundwater in the upper and lower aquifers. Figure 9 represents this information for the lower aquifer and Figure 10 for the upper aquifer.

2. Groundwater modeling and field observations showed the existing plant fire well can be pumped at a rate of 2,000 gallons per minute to remediate all contaminated groundwater in the deep aquifer, even when the Clark Street well is pumping at its current rate of 1,100 gallons per minute.

3. Field measurements showed that an upgraded shallow aquifer groundwater extraction system must be designed and installed to capture contaminated groundwater in the shallow aquifer. The analysis indicates that a properly designed and installed system can capture the bulk of the TCE contamination in the shallow aquifer.

4. Our analysis indicates that any contamination left over in the shallow aquifer (i.e. not captured by the shallow aquifer extraction system) will flow to the deep aquifer. As described in (2) above, our analysis shows that the deep aquifer extraction system as presently designed and operated will capture all of the contamination in the deep aquifer system. Therefore any contamination now in the deep aquifer system and/or remaining in the shallow aquifer system will be captured by the presently designed and operated deep aquifer system.



McGRAW-EDISON COMPANY
ALBION, MICHIGAN

FRED C. HART ASSOCIATES, INC
NEW YORK, N.Y.

FIGURE 5
TCE CONTAMINANT PLUME CAPTURE

CONTOUR INTERVAL: 1.0 FT. 4/9/86

LEGEND:
← FLOW LINE
H1 WELL NEST NUMBER AND SYMBOL
944.97 AND WATER LEVEL IN FEET
—945— POTENTIOMETRIC CONTOUR LINE

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FIGURE 90
TCE CONTAMINANT
PLUME IN SHALLOW AQUIFER
02/27/88
CONTOUR INTERVAL: 1FT.

LEGEND:
FLOW LINE
H1 955.18 WELL NUMBER AND SYMBOL, AND WATER LEVEL IN FEET
946 POTENTIOMETRIC CONTOUR LINE

2.0 Introduction

Fred C. Hart Associates, Inc. (HART) completed a hydrogeologic assessment of the McGraw-Edison site in Albion, Michigan, which defined the vertical and horizontal extent of groundwater contamination and defined the direction and rate of movement of the groundwater in the upper and lower aquifers. The effectiveness of the current aquifer remediation systems at the site were evaluated. It was demonstrated that effective groundwater remediation was possible at the site. Three-Dimensional groundwater modeling and field observations showed that the fire well, pumping at its current rate of 2,000 gallons per minute was adequate to remediate deep aquifer groundwater contamination, even with the Clark Street well pumping at its current rate of 1,100 gallons per minute. Field measurements showed that an upgraded shallow aquifer extraction system must be designed and installed to capture contaminated groundwater in the shallow aquifer. 25 specially designed HART wells were determined to be appropriate for quarterly sampling in a long term groundwater monitoring program to monitor the progress of aquifer remediation.

Volume I presented a statement of the geology, hydrogeology, and extent of contamination at the site. This report is Volume II of the hydrogeologic assessment, and contains data and calculations not available at the time the Volume I report was submitted. This report presents the procedures utilized and the conclusions reached regarding the effectiveness of groundwater remediation systems at the site. The evaluation of the deep aquifer remediation system required the use of complex computer groundwater models. The evaluation of the effectiveness of the shallow aquifer remediation system was accomplished by field measurements and calculations. Data and calculations are presented in Appendices.

Previous Activities

A large volume of data has been generated regarding the hydrogeology of the site. Prior to HART's involvement, several other investigators conducted studies at the site. The HART study was a comprehensive assessment of the vertical and lateral extent of contamination in soils and groundwater at the site and the movement of contaminants in and between aquifers. Volume I (HART, 1986) presented a discussion of the results of previous investigations, detailed the methodologies and results of HART's activities, and provided the basis for evaluating the effectiveness of the current groundwater remediation systems. One further important result of the HART work was wells, properly located and constructed with MDNR approval, for use in long-term monitoring of groundwater.

Dr. George F. Pinder and Dr. D.K. Babu of Princeton University conducted a review of site hydrogeologic data and utilized a computer model to show groundwater flow and predict the effects of remedial pumping at the site. The model chosen was a three dimensional finite element flow and solute transport model developed at Princeton University. The model was reasonably successful but the results of the model were unacceptable to the MDNR for several reasons. The MDNR contended that many wells were improperly constructed, providing potentially erroneous hydrologic data for input to the model. The MDNR also contended that the well locations were clustered in certain areas, not allowing adequate delineation of the extent and magnitude of the contaminant plume. These concerns, primarily expressed by MDNR, were properly addressed by HART in this investigation by having MDNR approve all work plans for monitoring well location, installation, sampling and analysis prior to the work being carried out. In addition, MDNR personnel made frequent inspections of the field work to ensure its conformance with the approved work plans.

<u>The Modeling Process</u>

Groundwater models are used to represent simplified versions of groundwater flow and contaminant transport systems. Models are based on field data, and, once calibrated, can be used to predict values of unknown variables. Mathematical models consist of a set of differential equations which are known to govern the flow of groundwater (Wang and Anderson, 1982).

Two types of mathematical models were considered for this site, the finite element model and the finite difference model. Each model has advantages and disadvantages. The finite element model, chosen by Pinder and Babu, has the advantage of providing solutions to solute transport problems. The disadvantage is that currently, finite element models can only be used on large mainframe computers. Conversely, finite difference models have recently been converted for use on microcomputers, and are therefore, faster and easier to use. Finite difference models, however, do not lend themselves to solute transport problems. After reviewing the Pinder modeling work, it was determined that finite element models could not provide reliable solute transport solutions at low part per billion concentration levels for the McGraw Edison Site. After discussion with David A. Hamilton, P.E., a groundwater modeler with the MDNR, it was decided that the finite difference model could provide the same solutions to groundwater flow as the finite element model, and that solute transport estimates were not critical.

The model chosen was the Modular Three-Dimensional Finite-Difference Groundwater Flow Model by Michael A. McDonald and Arlen Harbaugh (USGS, 1984). The McDonald-Harbaugh Model was chosen because it is perhaps the most widely-used flow model, has the best documentation, and has a proven record at sites such as McGraw Edison. The Microcode Version (Microcode, 1985) was chosen for its compatibility with HART's IBM equipment. HART's hardware consists of a 640K IBM-AT personal Computer with 30 megabyte Hard Drive and two disk drives, with an 8087 Math Coprocessor. Maps were plotted on an HP-7475 6 pen plotter and a Houston Instruments DMP-52 plotter using the Geoplot program (GEOPLOT, 1986).

After the model was chosen, all data collected by the various investigators was plotted on maps showing thicknesses, hydraulic conductivities, water levels and other information from each aquifer. An appropriate grid was set up, and data arrays for each parameter were assembled. The model was then calibrated to known site conditions. At that point, several pumping schemes were tested to determine the effects of pumping in the aquifer and then compared to actual pumping results.

Structure of the Report

This report details HART's efforts to model the effectiveness of the current deep and shallow aquifer remediation systems. Chapter 2 discusses model set up including the definition of the grid, boundary conditions, the multiple layer system, and site hydrologic parameters. Chapter 3 reports the process of calibration of the model and the predicted effects of pumping produced by the model.

It was determined in the course of modeling that the scale of the model was too large to evaluate the effectiveness of the shallow aquifer remediation system. For this reason, different methodologies were used, and these are reported separately in Chapter 4 of this report.

Chapter 5 presents conclusions with regard to the effectiveness of the current deep and shallow aquifer remediation systems, and recommendations for appropriate aquifer remediation systems and long term groundwater monitoring systems for the site.

All data input to the model are presented in Appendices, including data files after steady state and transient calibration and data for simulation scenarios. Appendices also include all field data and data interpretation for aquifer pump testing activities.

3.0 Model Set Up

Chapter 2 of this report presents a discussion of the various tasks which were required to properly set up the model to simulate the McGraw-Edison site. First, a grid comprised of 1,505 cells was developed and boundary conditions defined. The hydrogeologic system at the site was then examined to identify the various geologic layers of importance and their hydrologic characteristics. Once the layers were characterized, the various hydrogeologic parameters were defined. Data maps were constructed for each parameter and the data was entered into the computer.

Establishing the Grid

Field results of previous investigations and results of previous reports were examined to determine the existence of physiographic or geologic boundaries which could act as limits to groundwater flow in the model. Data was also checked to determine the areal extent of any expected changes in groundwater flow due to different pumping scenarios. After reviewing the report on the results of Pinder's and Babu's modeling efforts (FTCH, 1984), MDNR expressed concern that the finite element grid used in that model did not extend far enough to the east, as evidenced by the skewed flow lines in the potentiometric surface map for fire well pumping in the deep aquifer presented in the FTCH report. After discussions with MDNR, it was agreed to extend grid coverage to the east. Coverage was approved by the MDNR prior to the development of the data arrays.

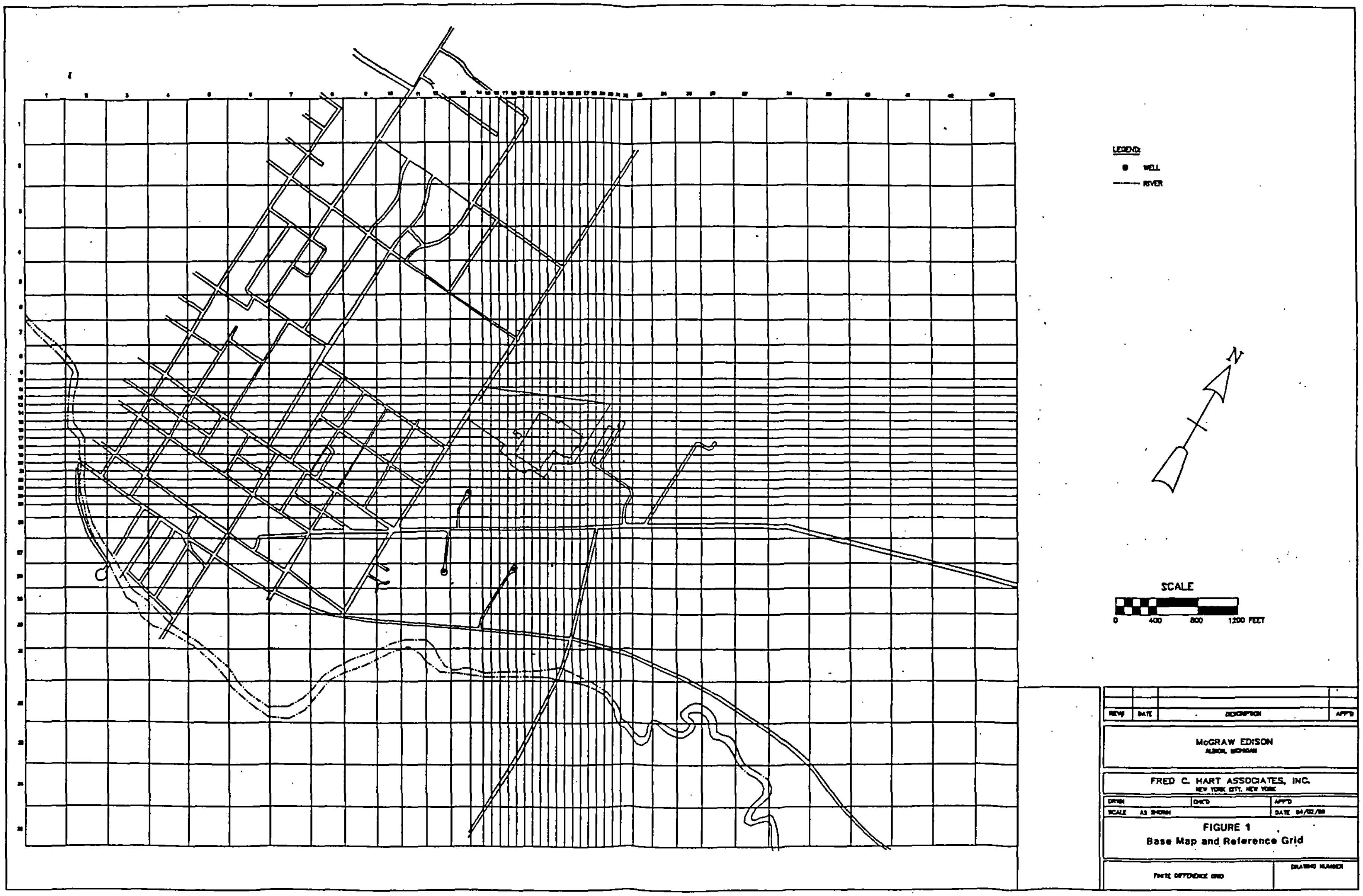
Next, the concentration of data points was examined by mapping all boreholes or wells installed by investigators at the McGraw Edison Site. The data concentration at the center of the grid, in the area of the fire well, appeared to be such that an 80 foot grid spacing would produce cells with the proper coverage in that area. A second zone which surrounded the center of investigatory activity indicated that a 240 foot grid spacing would be adequate. A third zone, lying generally beyond the investigated areas was still necessary to include in the model. A 400 foot grid spacing was adequate in that area. Because the relatively large differences between the various grid spacings could adversely affect the mathematical calculations, several rows of blocks with intermediate spacings were added between the 80 and 240 foot spacings and the 240 and 400 foot spacings. The final grid was then superimposed on a base map of the area using the HART Texas Instruments Computer-aided Drafting (CAD) system. The grid and base map are shown in Figure 1.

Defining Boundary Conditions

Two layers were identified for incorporation in the model. Layer 1 consists of the shallow aquifer unit. Layer 2 consists of the deep aquifer unit. The confining unit that separates the two aquifers, although it could be considered a separate layer, was treated as a separate unit by setting up an array called Vcont (vertical conductivity), a technique which will be discussed later in this chapter. All boundaries were defined as the edges of the grid, except where the grid was truncated by the river, in which case the river became the boundary. For both layers, all border boundary conditions were defined as constant head because recharge/discharge relationships were known and are not likely to change significantly over time. Cells in the center of the grid were defined as variable head, because they vary with time. All cells on the opposite side of the river were defined as inactive cells. Figure 2 shows the boundary conditions assigned to the model.

Defining Multiple Layers

Layer 1 is defined as the upper aquifer unit. Layer 2 is defined as the deep aquifer. The presence of the low conductivity confining unit between the layers was also included in the model. In this case, the representation of this unit as a low conductivity layer, however, can be accomplished without formal assignment as a model layer. This was done using the Vcont array. This procedure avoids the difficulties of assigning heads to the confining layer cells.


LEGEND:
WELL
RIVER
N
SCALE
0 400 800 1200 FEET
REV# DATE DESCRIPTION APP'D
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NEW YORK CITY, NEW YORK
DRWN CHK'D APP'D
SCALE AS SHOWN DATE
FIGURE 1
Base Map and Reference Grid
FINITE DIFFERENCE GRID DRAWING NUMBER

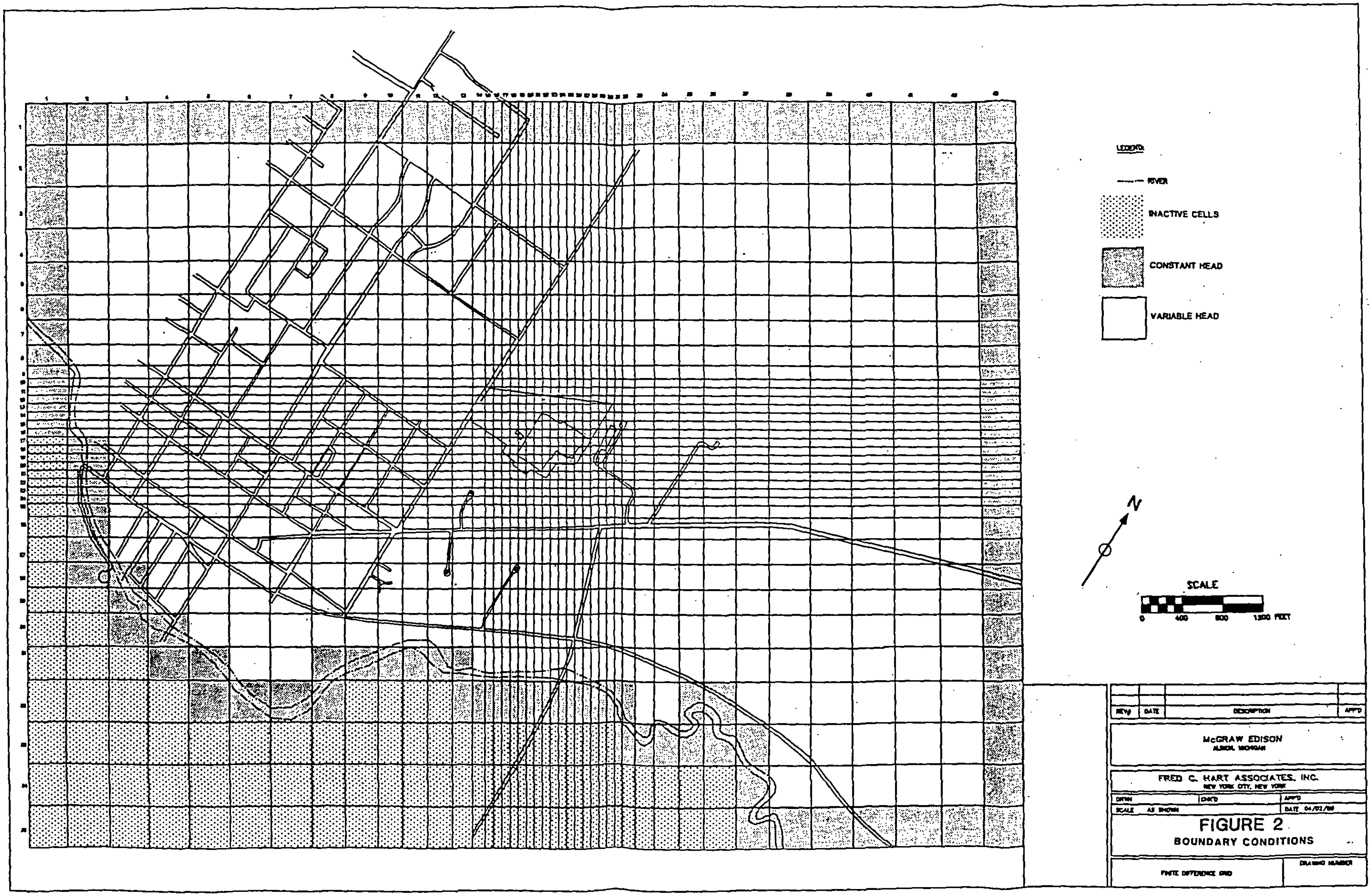


FIGURE 2
BOUNDARY CONDITIONS

Each layer in the model received a "layer-type code" which describes the hydrologic condition of the layer. Each layer-type requires different equations and data sets to run the model, so it was important to define the proper layer-type in order to assemble the necessary data sheets. The upper aquifer, Model Layer 1, was assigned to Layer-Type Code 1, denoting that this layer is strictly unconfined. The Deep Aquifer, Model Layer 2, was assigned layer-type code 3, denoting that this layer is fully convertible between confined and unconfined conditions. Because of the presence of the confining layer in some areas and "windows" in other areas across the site, the use of the Layer-type 3 code was critical since it limits vertical leakage from the aquifer above at unconfined cells.

Following the layer-type assignments, data arrays were identified and filled.

Setting Up the Arrays

In order to run the model, complete data sets were entered in the form of two dimensional data arrays. Every data set required the creation of an array referenced to the grid. The grid was entered by specifying two one-dimensional arrays: DELC which specifies column space and DELR which specifies row spacing. All other arrays were two dimensional arrays which were automatically referenced to the grid. Arrays utilized for initial head and boundary conditions can be found in Appendix 1. Other initial conditions are printed in the first part of the steady state calibration run (Appendix 2) and the transient calibration run (Appendix 3).

Next, boundary conditions were entered as data sets, one array for Layer 1 and one array for Layer 2, followed by stratigraphic information, which was also defined as a set of arrays. First, information was gathered from all previous reports regarding site geology and hydrogeology and carefully plotted out on a series of maps. One map showed the top of the confining unit, or the bottom of the shallow aquifer. Another map showed the bottom of the confining layer. It was necessary that confining layer thickness included zones from the top of the clay-silt unit to the bottom of the clay-silt unit. For many cases, this included sand lenses in between. Although the next unit is generally bedrock, a small amount of overlying high permeability drift material in several remote locations had to be included, as well. Another array was used to set the bottom of the deep aquifer unit. These three arrays defined the locations of stratigraphic changes in geology and were used by the computer to construct the two layers for the model.

Next, initial head (water level elevations relative to mean sea level) measurements were entered into two arrays representing water levels in the shallow and deep aquifers, respectively. Likewise, the hydraulic conductivity estimates were entered into two arrays representing the shallow and deep aquifer. Conductivities of the upper aquifer were obtained from laboratory permeability measurements. Conductivities for deeper zones were calculated from pump test results.

An array was created for Vcont to represent the low conductivity unit not treated as a layer by the model. Vcont was calculated by taking the hydrologic conductivity and dividing by the thickness of the clay. To distinguish between the presence and absence of clay windows, Vconts were entered that were the same for the aquifer above, along with a one-foot clay thickness where the clay was absent. Some low permeability zones included sand lenses. To consider this problem, Vconts were adjusted for sand thicknesses and permeabilities. The use of Vcont avoided the difficulties of assigning heads to the confining layer.

All matrix arrays defining the geology (top of clay, bottom of clay), hydrogeology (upper aquifer head and conductivity, lower aquifer head and conductivity) and Vcont were assembled from approximately 150 data points. Data for all other points was interpolated on maps by hand contouring each limited data set and constructing data files. It was this interpolation which was generally adjusted during calibration stages of the model. Before final assembly of the data sets, all units were converted to feet and days. All geology and head measurements were entered in elevations relative to mean sea level.

Anisotropic conditions, where the hydraulic properties such as conductivity of an aquifer vary according to the direction of flow, were analyzed for the shallow and deep aquifer systems. Based on this analysis, it was determined that insufficient data existed regarding anisotropy. After consultation with MDNR (Hamilton, 1986b), this factor was omitted from consideration in the model.

Once all the arrays were properly set up, the model was calibrated for steady state conditions.

4.0 Calibration and Use of the Model

Once the hydrogeologic regime was understood and all necessary data arrays had been filled, the model was run to see how well it would predict natural flow conditions at the site. The output was compared with actual observed field measurements for steady state conditions to see if the computer could model the aquifer flows at the site.

Strongly Implicit Procedure

The Strongly Implicit Procedure (SIP) is a method for iteratively solving a large system of linear equations. Since this is a mathematical model, the model must first be made to solve the mathematics given the data arrays that have been set up for the site before actual calibration of the hydrogeologic parameters can be performed.

One equation is written for each cell to express the relationship between the head in the cell and the heads in all the surrounding cells. This requires that the equations must be solved simultaneously.

The solution of all the equations consists of the head for each node. SIP starts with an estimate of the solution and successively refines it. At each iteration, SIP tries to determine how much head should be changed from the previous estimate so that the system of equations can be satisfied. The procedure eventually converges to a solution.

Iteration parameters are necessary for the procedure to converge, and they are calculated during each run. The ratio of the geometric progression of the iteration parameters is called the "seed," specified in the model as "WSEED." Five iteration parameters were specified by the model for SIP. WSEED was calculated first by the program for these data arrays in this model. After indications of an approximate seed from early model runs, WSEED was manually specified to manipulate the equation solving process.

If WSEED is too large, heads which are too small for the best estimate are calculated, called undershooting. If WSEED is too small, heads which are too large for the best estimate are calculated, called overshooting. Problems of non-convergence were first diagnosed by determining if severe overshooting or undershooting occurred. This was done by examining the maximum head change for each iteration. Since the model appeared to be consistently overshooting, undershooting was employed first by adjusting the acceleration parameters downward. The model did not converge. Overshooting was rectified by changing the HCLOSE (closure criterion) for SIP and manually adjusting the seed. The percent discrepancy allowed for the water budget needed to be as small as possible. The volumetric water budget is the difference between the amount of water input to the model and the calculated amount of water out of the model at the end of each stress period. The calculated budget discrepancy was measured to be 1.15% at the end of the last iteration of the steady state calibration. The budget discrepancy at the end of the last time step in the last stress period for the transient calibration was - 0.40%.

<u>Adjustment of Array Data</u>

Following the convergence of the model, runs were plotted out as contour maps. Maps showing final steady state model calculated heads were compared to maps showing the initial head input data. The computer printout for the steady state calibration run can be found in Appendix 2.

Differences in actual and predicted head maps were noted. Data in particular areas of the arrays were manipulated in an attempt to calibrate the model. Initial input heads were taken from actual field measurements. Recharge was estimated at approximately eight inches per year, and compared to existing estimates of recharge data. Existing estimates of recharge data were compiled from Albion precipitation data and from Lansing evaporation data, the closest location for which evaporation data was available. Stratigraphy, for the most part, was also fairly well defined. Parameters adjusted during calibration were Vcont, which controlled the location of the windows through the confining layer, and the hydraulic conductivity, which can be highly variable and probably provides the most sensitivity to model results.

Input parameters were adjusted in the arrays to match the natural steady state conditions measured in the aquifer. Following the transient calibrations during steady state and pumping conditions, revised steady state calibrations were run to ensure the accuracy of the calibration. Figures 3 and 4 show the initial measured heads and the calibrated steady state heads for the shallow aquifer, respectively. Figures 5 and 6 show the initial measured heads and the calibrated steady state heads for the deep aquifer, respectively. The steady state conditions predicted by the model were determined to be within acceptable limits for the purpose of groundwater modeling at the McGraw-Edison site, so that steady state calibration was determined to be complete, and the aquifer systems were ready to be studied.

Simulation of Aquifer Pumping

Once steady state calibration had been reached, it was necessary to perform a transient calibration step. The transient calibration is necessary because parameters which control transient flow need to be specified and included in the calculation. Specific yield for both the shallow and deep aquifers needed to be specified, along with storage coefficient for the deep aquifer. The specific yield was specified for the deep aquifer because it has been defined as a layer type 3 condition, indicating that the layer is fully convertible between confined and unconfined conditions. Unlike the steady state calibration where one time step per stress period was sufficient, 15 time steps were necessary for the model to equilibrate with these new parameters. The first stress period of any simulation run was always a steady state calibration under transient condition. The transient calibration run can be found in Appendix 3. The second stress period is the period when extraction well pumping occurs. For this stress period, constant groundwater pumping rates for the period were specified. Two scenarios were simulated at the site. The first was the fire well pumping at 2,000 gpm and the Clark Street well pumping at its current rate of 1,100 gpm. The second was the fire well pumping at 3,000 gpm and the Clark Street well pumping at its current rate of 1,100 gpm.

Maps were plotted out for both aquifers at the end of the first stress period to observe simulation of the water levels before pumping activities. The computer printout for both of these scenarios can be found in Appendix 4. Storage, specific yield and conductivity were adjusted accordingly in subsequent runs to provide accurate model calibration.

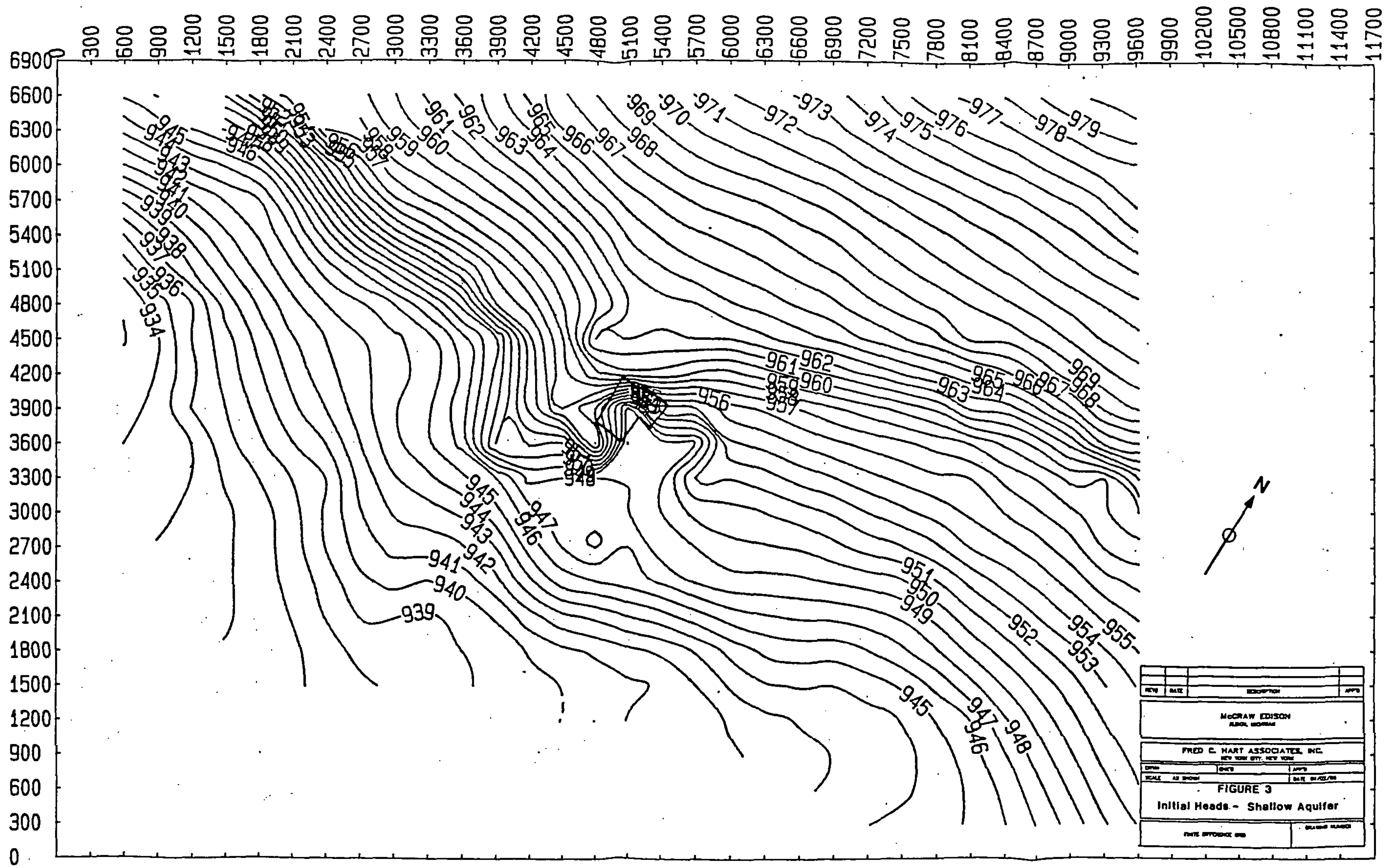
Maps showing simulated groundwater flow for both of the aforementioned scenarios were generated from pumping heads (calculated water level elevations) at the end of stress period two. These maps are shown as Figure 7 and Figure 8 respectively. Figure 9 is a map showing the observed groundwater flow patterns for the current pumping conditions at the site. This map was compared with the computer simulated maps. This process was repeated until the computer simulated maps adequately matched the pumping condition.

Assessment of the Deep Aquifer

Comparison of the actual flow map with the computer generated flow map indicates that even under the set of conditions with the fire well pumping at 2,000 gpm and the Clark Street well pumping at 1,100 gpm, the extent of the contaminant plume falls within the reach of the plume capture boundary produced by the fire well. Generally, the faster the fire well is pumped, the higher gradient is created and the faster aquifer restoration will occur.

Although the effects of the Clark Street well reach considerably into the deep aquifer contaminant plume, the well can be pumped without receiving contamination from the site. In order to do this, the existing groundwater divide will be maintained. The presence of this divide can be monitored by checking water levels in the existing monitoring wells.

Given these facts, the optimum pumping rate for the fire well should be determined during actual operations by stepping up the pumping rate while monitoring interconnected hydrologic features, e.g., wells and springs. Field data for the deep aquifer can be found in Appendix 5.



McGRAW EDISON

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SCALE AS SHOWN

FIGURE 3

Initial Heads - Shallow Aquifer

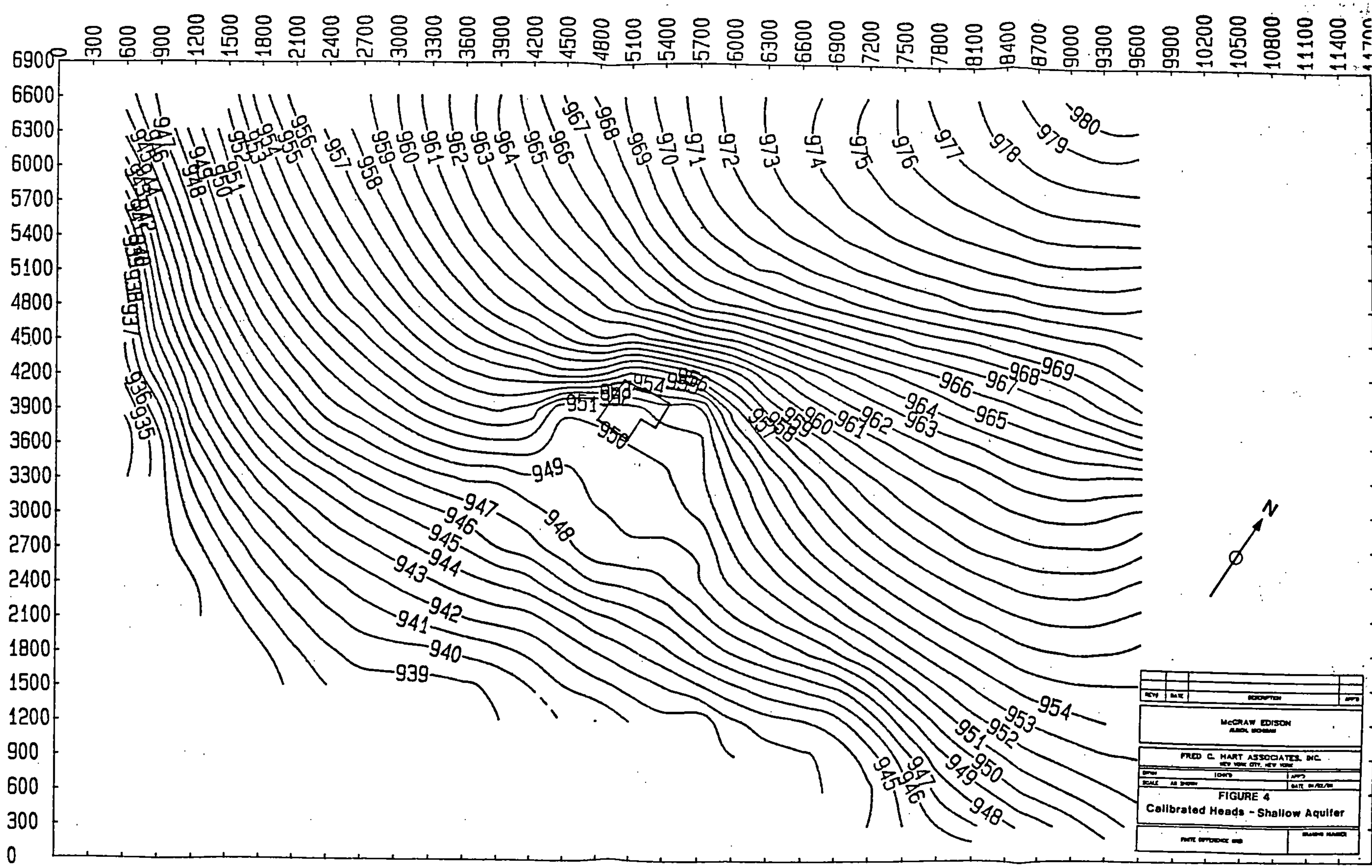
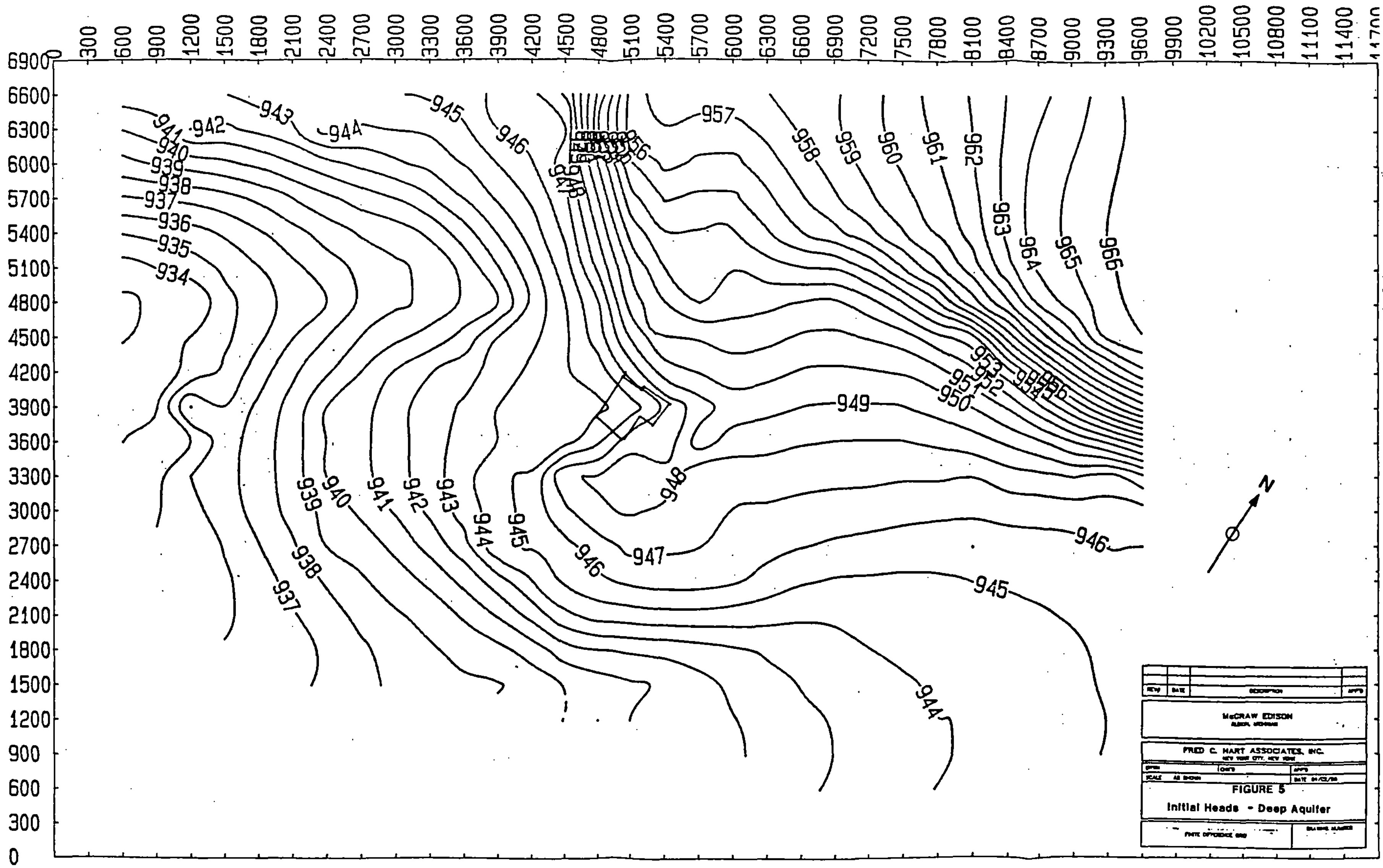


FIGURE 4
Calibrated Heads - Shallow Aquifer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SCALE AS SHOWN
FIGURE 5
Initial Heads - Deep Aquifer
N
934
935
936
937
938
939
940
941
942
943
944
945
946
947
948
949
950
957
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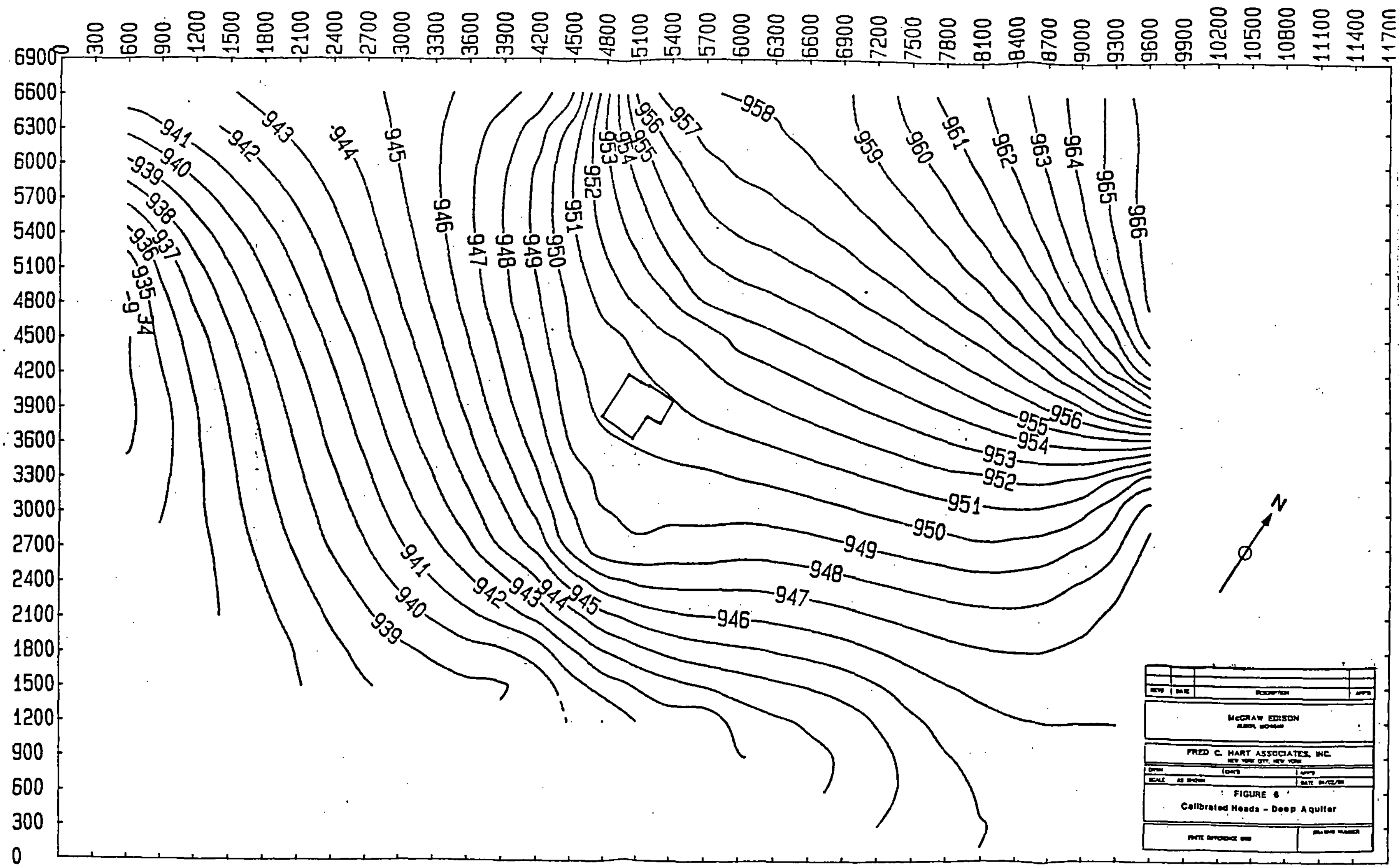
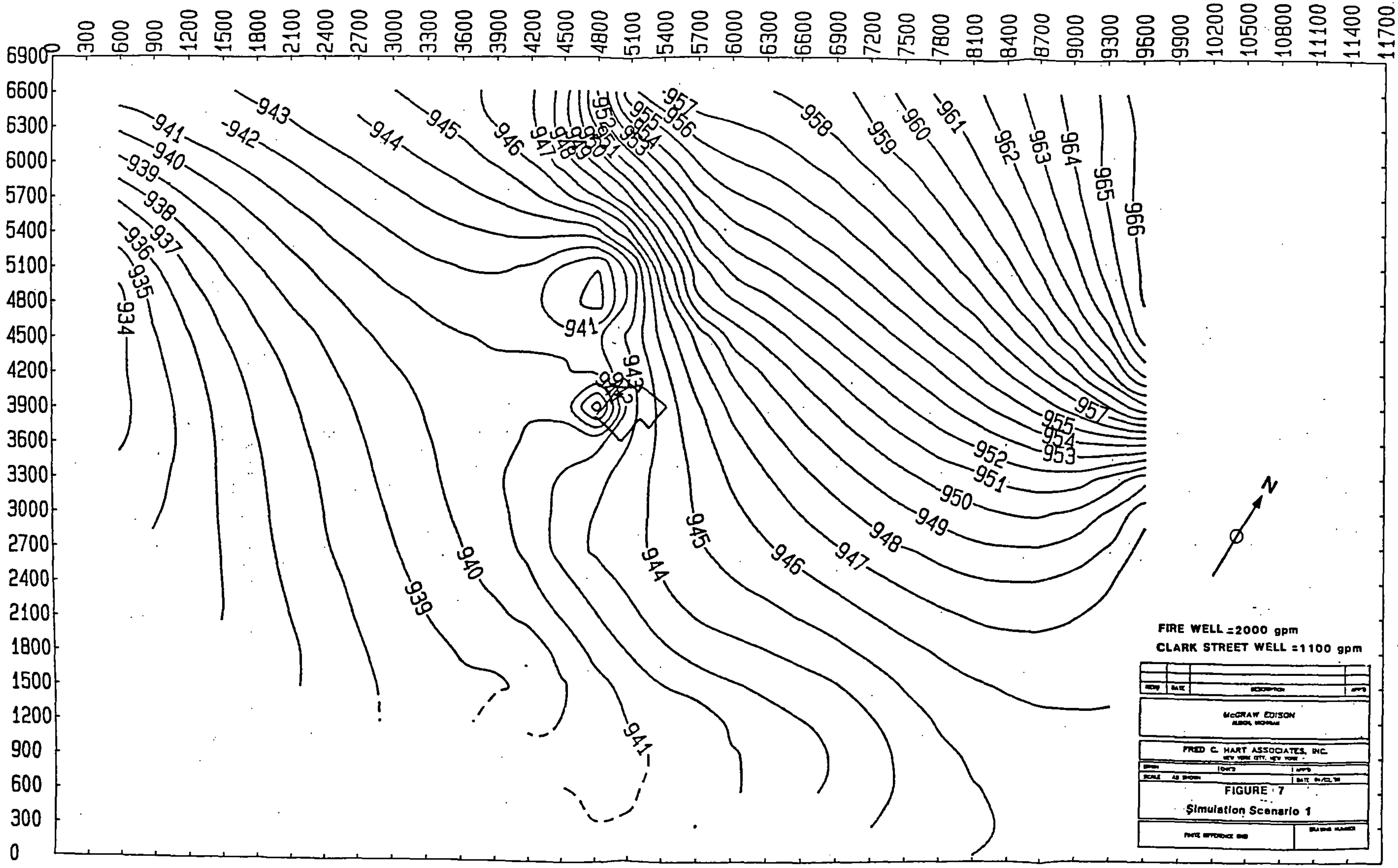
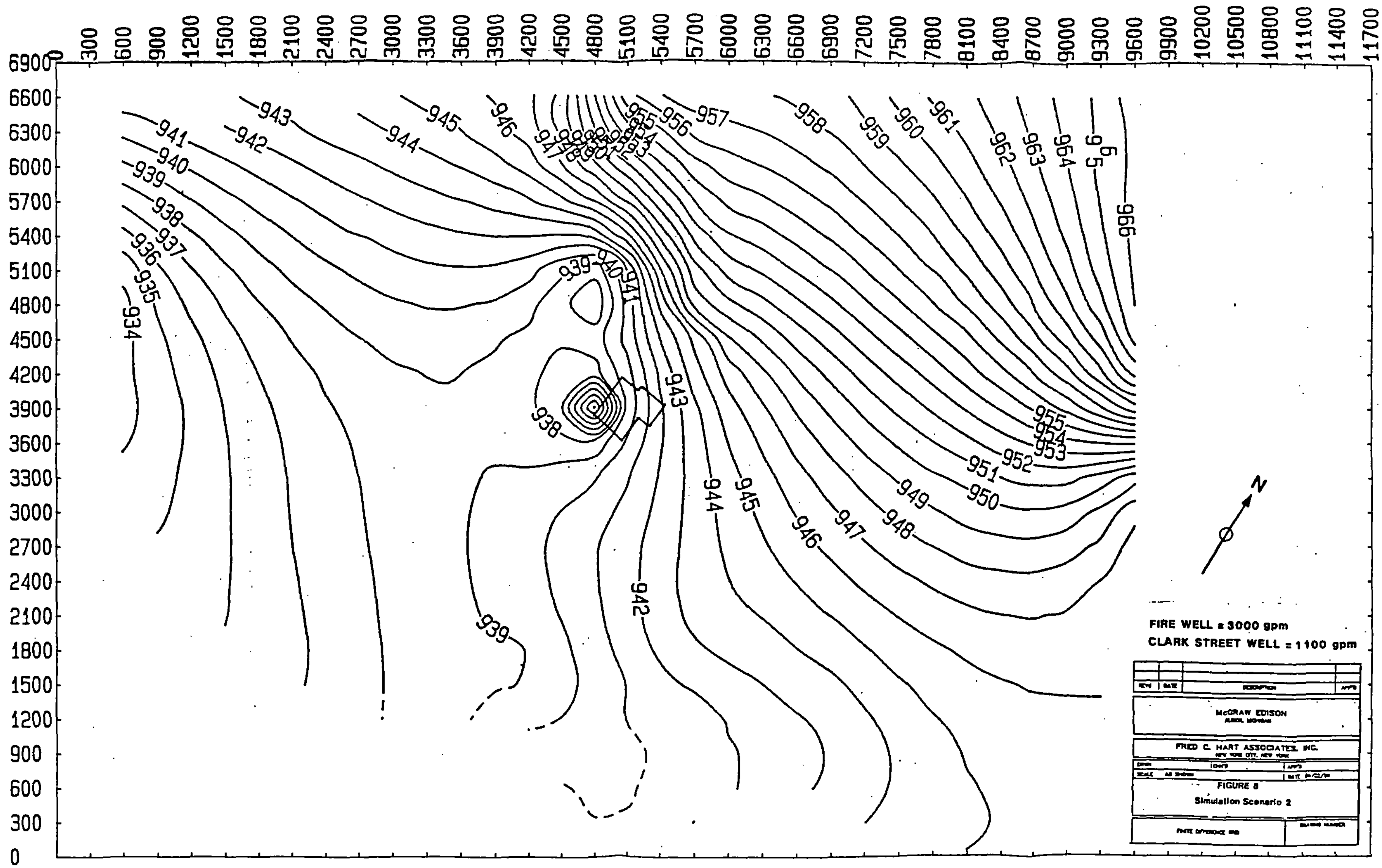
961
962
963
964
965
966


N
McGRAW EDISON
FRED C. HART ASSOCIATES, INC.
NEW YORK CITY, NEW YORK
FIGURE 6
Calibrated Heads – Deep Aquifer


FIRE WELL =2000 gpm
CLARK STREET WELL =1100 gpm
McGRAW EDISON
FRED C. HART ASSOCIATES, INC.
NEW YORK CITY, NEW YORK
FIGURE 7
Simulation Scenario 1
N


FIRE WELL = 3000 gpm
CLARK STREET WELL = 1100 gpm
McGRAW EDISON
FRED C. HART ASSOCIATES, INC.
NEW YORK CITY, NEW YORK
FIGURE 8
Simulation Scenario 2
N
934
935
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960
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963
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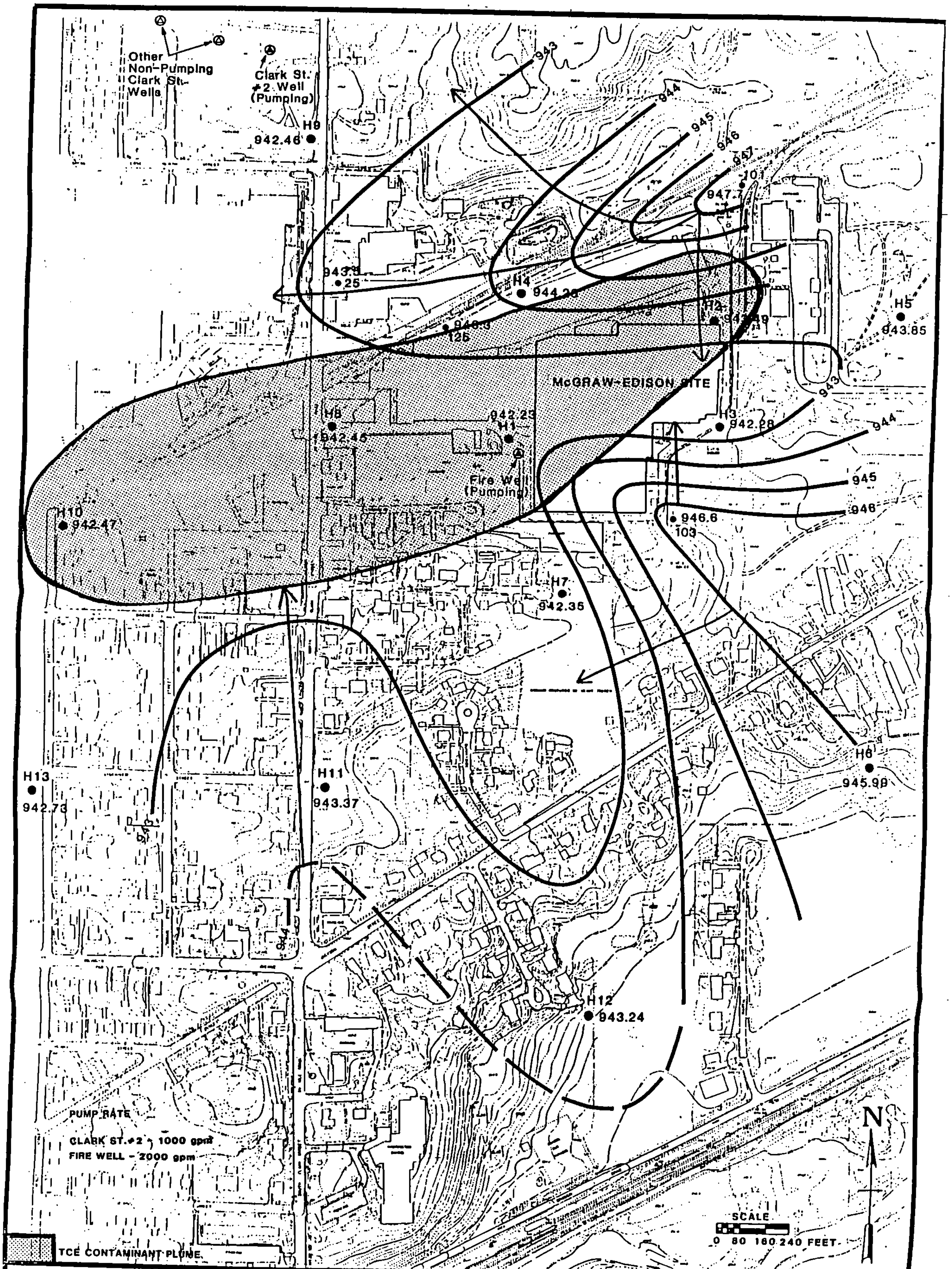
966
0
300
600
900
1200
1500
1800
2100
2400
2700
3000
3300
3600
3900
4200
4500
4800
5100
5400
5700
6000
6300
6600
6900
7200
7500
7800
8100
8400
8700
9000
9300
9600
9900
10200
10500
10800
11100
11400
11700



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ALBION, MICHIGAN

FRED C. HART ASSOCIATES, INC
NEW YORK, N.Y.

FIGURE 9
TCE CONTAMINANT PLUME CAPTURE

CONTOUR INTERVAL: 1.0 FT. 4/9/86

LEGEND:
← FLOW LINE
H1 ● 944.97 WELL NEST NUMBER AND SYMBOL AND WATER LEVEL IN FEET
—945— POTENTIOMETRIC CONTOUR LINE

5.0 Shallow Aquifer Assessment

One objective of the HART study was to determine whether the existing shallow aquifer recovery system was effective in containing the shallow aquifer TCE contaminated plume. Examination of the data shows that the lateral coverage of the current shallow aquifer groundwater recovery system is not adequate to control the shallow aquifer TCE contaminant plume. Questions also remained as to the spacing of the wells and optimal pumping rates. This chapter describes the evaluation of the effectiveness of the current shallow aquifer remediation system and identifies an effective modified system.

Assessment of the Current Extraction System

Prior to the construction of the current shallow aquifer purge well system, several pumping tests were conducted in the shallow aquifer to determine the aquifer characteristics. EWA of Minneapolis, Minnesota, conducted a pump test in March, 1984. The aquifer characteristics determined by the EWA pumping tests were inconclusive due to low pumping rates, short test duration, problems associated with snow melt and lack of specific capacity data from the pumping well (FTCH, 1984).

In order to verify these results, FTC&H conducted a second pumping test in August, 1984. The maximum pumping rate of the first test was 5.83 gpm. The maximum pumping rate of the second test was 4.0 gpm. Conclusions of the FTC&H report on shallow aquifer testing indicated that a system of purge wells located in the aquifer was technically feasible, although the available yield could be limited (FTC&H, 1984). The optimum pumping rate for these purge wells was to be determined following the completion of a pumping test of each well.

FTC&H also noted that a total pumping rate of 23 to 32 gpm was required to contain the shallow aquifer contaminant plume. The extent of that contaminant plume was unknown at the time. Additionally, although information on the maximum pumping rate for each purge well was collected by the well installation contractor, no attempt was made to confirm that the plume capture boundaries necessary to contain contamination were actually developed by the purge well system.

In order to check the effectiveness of plume capture by the shallow well system, HART conducted a field test. Following the completion of well H3S by HART in August, 1985, the shallow well extraction system was turned on. Well H3S, approximately 48 feet away from purge well PW-4, showed no effect. Since the radius of influence of a well has to reach a minimum of 50 feet to affect plume capture when wells are spaced 100 feet apart, suspicion was cast on the effectiveness of that system.

To indicate the effectiveness of the system, pump test data was necessary. Since that was not available an equation which indicated the radius of influence of a pumping well was used. This equation is shown below and discussed:

Sichart (Powers, 1981)

$$R_o = 3\ (H - h)\ K$$

Where R_o = radius of influence
$(H - h)$ = drawdown in the pumping well
K = hydraulic conductivity

Reports by Fishbeck provided a drawdown value of 6.25 feet, and a hydraulic conductivity value of 4.64 x 10^{-5} cm/sec. The result of this equation was 12.77 feet.

The results of this equation indicate that the radius of influence exerted by each of the purge wells could not extend to intersect adjacent purge wells, which was verified by the preliminary observation at well H3S. Based on this preliminary information, the shallow aquifer recovery system was judged to be inadequate.

Shallow Aquifer Extraction System Conceptual Design

The extent and direction of flow of the contaminant plume in the shallow aquifer was reported in Volume I of this study (HART, 1985). The flow of contaminants downward is precluded by the presence of a low permeability aquiclude unit. Figure 10 shows the extent of the shallow aquifer contaminant plume. With the extent of contamination and the position of the confining unit documented, a preliminary layout of a shallow recovery well system was developed and is presented in Figure 11.

A field test was conducted by HART in April, 1986. A memorandum describing the results of that test is included in the Appendix. Field testing included the installation of four piezometers in order to determine the effective drawdown distance of a pumping well in the shallow aquifer. Results of the drawdown tests are also included.

The field results were analyzed and the data applied to standard equations in an effort to determine distance drawdown curves. Initially, an effort was made to use the Cooper-Jacob method to interpret the data, but because several conditions necessary for proper application were not met, (such as fully penetrating wells and a constant discharge rate), the Cooper-Jacob method was determined to be inapplicable and an alternative method was used to determine the effective radius of influence.

The alternative method was to plot out the drawdown based on the actual field measurements to impirically determine the radius of influence. Effective extraction well systems must overcome natural gradients and pull contamination in towards the entire extraction well line under the influence of a pumping gradient. Figures 12 and 13 are plots of the actual measured natural and pumping gradients with interpolation to 25 feet. Figure 12 shows a cross-section normal to groundwater flow along the line of extraction wells. This figure demonstrates that the drawdown at 25 feet away from the pumping well will overcome the natural groundwater gradient to the extent of providing capture at any point between extraction wells out along the well line with a well spacing of 50 feet.

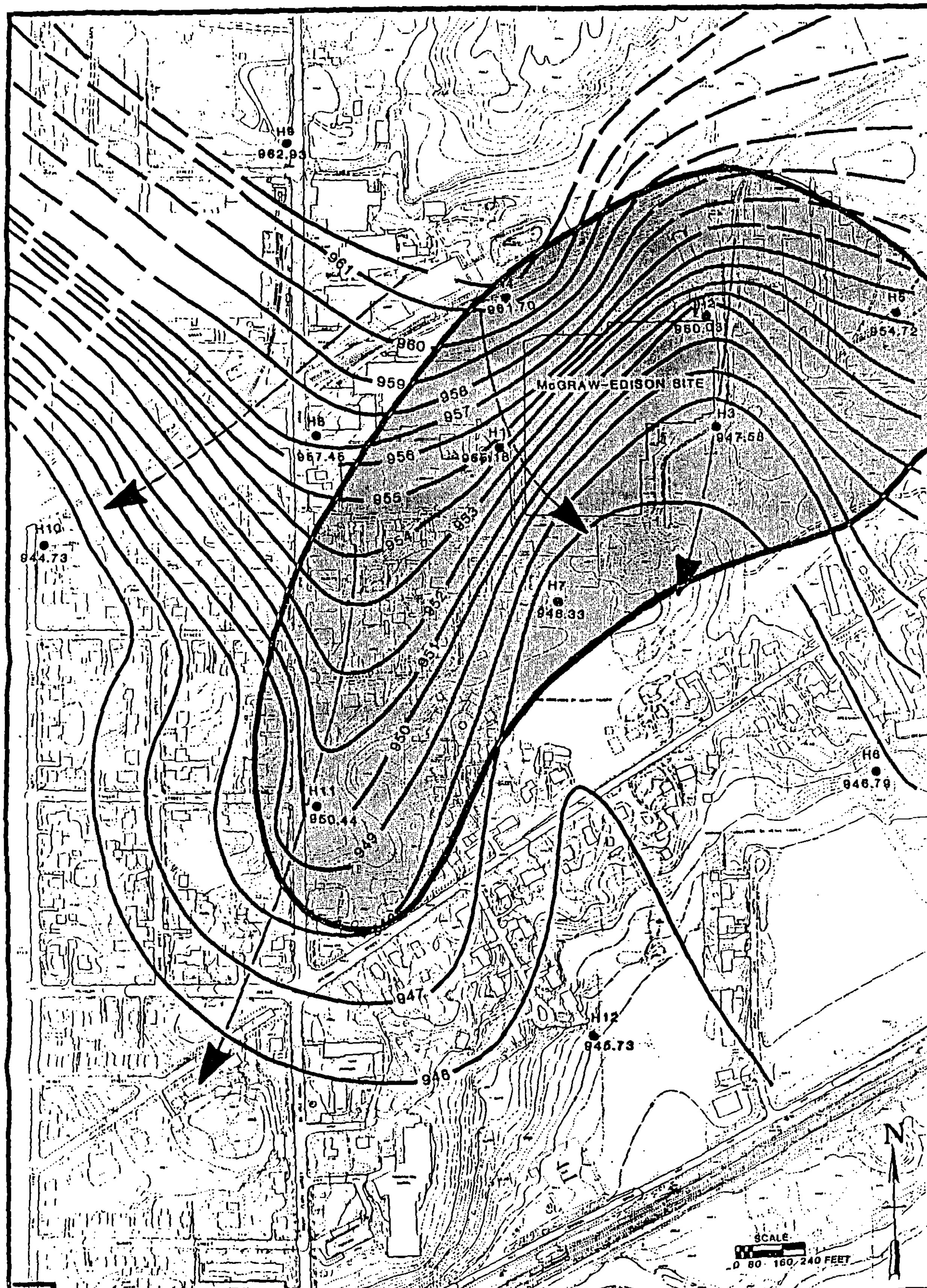

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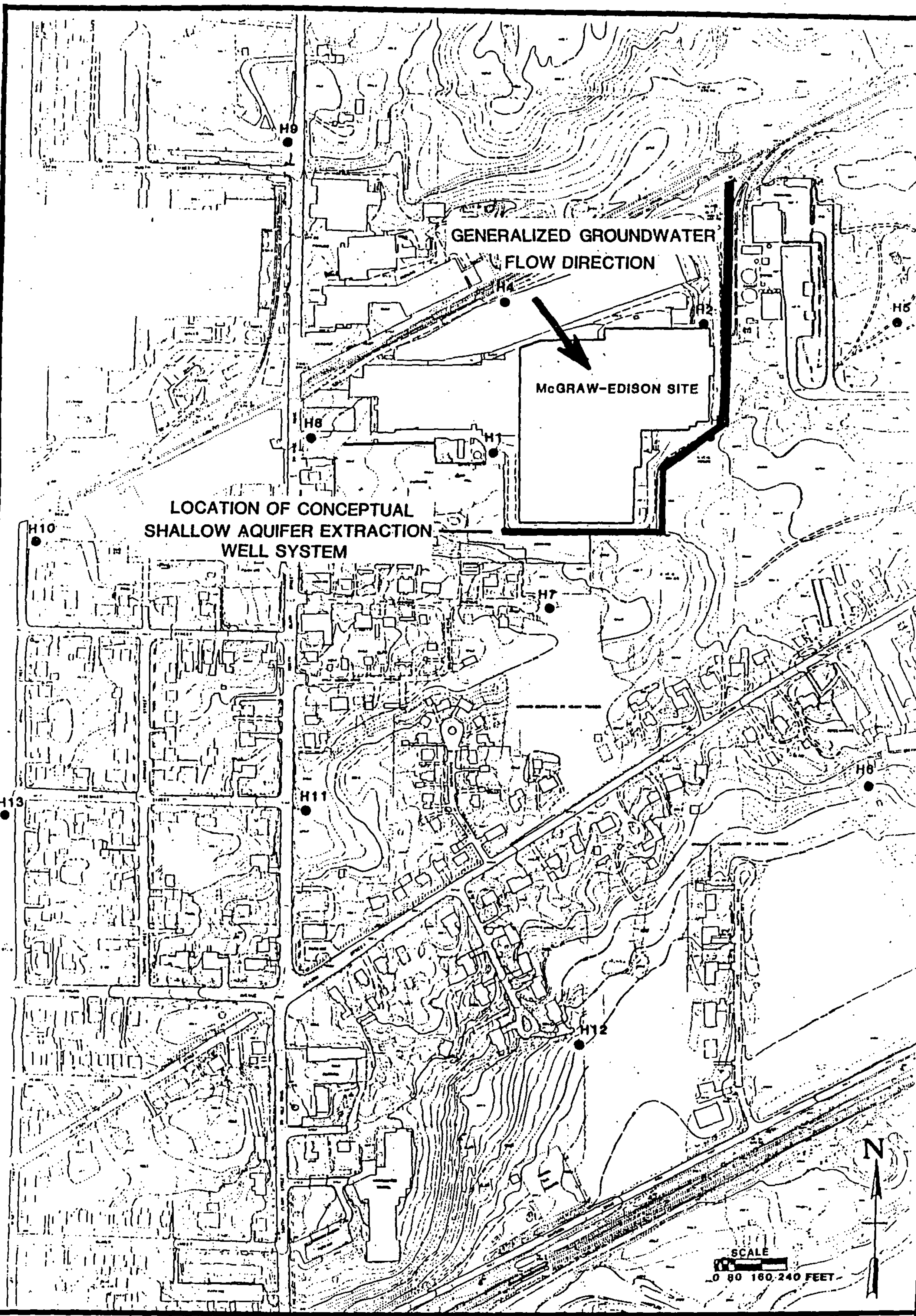
FIGURE 10
TCE CONTAMINANT
PLUME IN SHALLOW AQUIFER
02/27/86
CONTOUR INTERVAL: 1FT.

LEGEND: FLOW LINE
H1 955.18 WELL NUMBER AND SYMBOL, AND WATER LEVEL IN FEET
946 POTENTIOMETRIC CONTOUR LINE



FRED C. HART ASSOCIATES, INC. NEW YORK, N.Y.	LOCATION OF CONCEPTUAL SHALLOW AQUIFER EXTRACTION WELL SYSTEM	FIGURE 11 DATE: 6-18-86

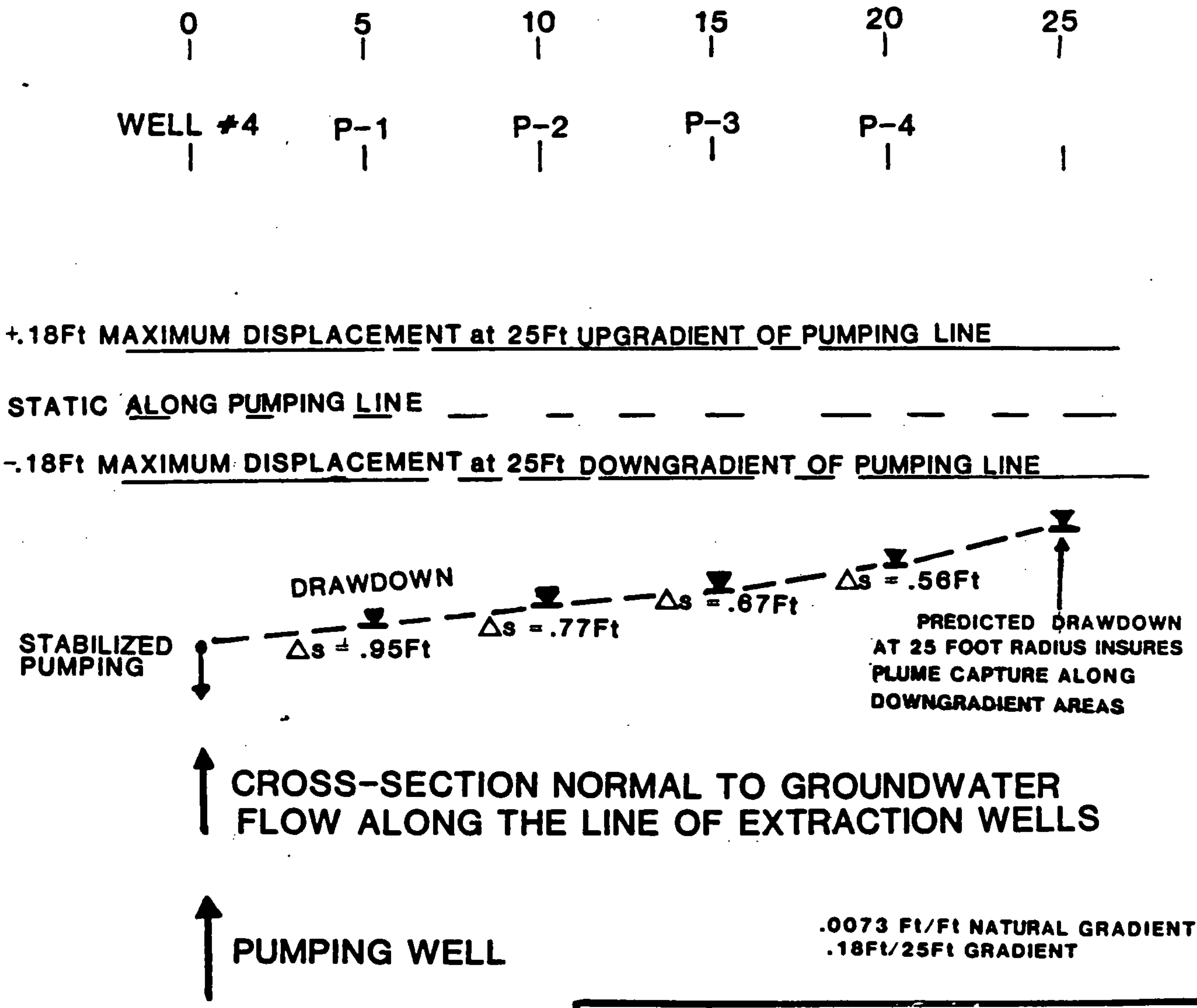


FIGURE 12

CROSS-SECTION NORMAL TO GROUNDWATER FLOW

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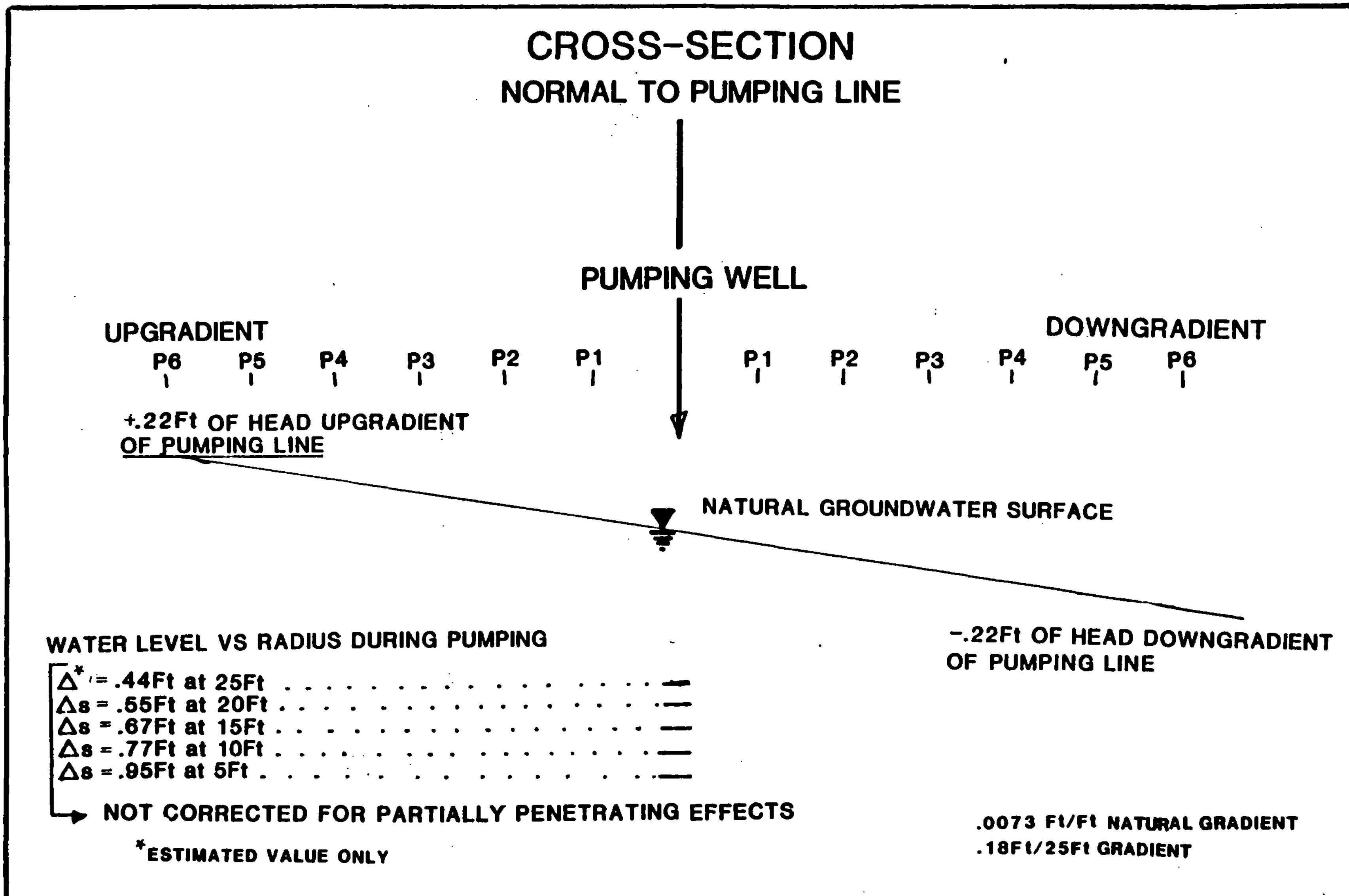

WITH NO CHANGE IN LEVELS UPGRADIENT OR DOWNGRADIENT AT 30Ft (WORST CASE ESTIMATE), CAPTURE ZONE WILL STILL DRAW WATER NORMAL TO PUMPING LINE AT A 25Ft CAPTURE RADIUS

FIGURE 13
CROSS-SECTION PERPENDICULAR TO GROUNDWATER FLOW

FRED C. HART ASSOCIATES, INC.

Figure 13, which shows a cross-section perpendicular to the extraction well line, indicated that the purge well pumped at the optimal pumping rate will effectively capture groundwater at a distance up and downgradient. At a distance of 25 feet perpendicular to groundwater flow (along the pumping line), groundwater will still be flowing toward the extraction well.

This analysis shows that an extraction well spacing of 50 feet and a minimum pumping rate of 7 gpm would provide intersecting cones of influence to overcome natural gradients and intercept shallow aquifer groundwater contamination. This is shown conceptually in figure 14. The extent of the shallow aquifer extraction well system shown on figure 11 requires approximately 35 wells to intercept contamination in the shallow aquifer before it leaves the McGraw Edison plant site. Off site contamination in the shallow aquifer which lies outside of the shallow aquifer extraction well line will be remediated by the deep aquifer extraction system. In those off site areas, the clay is discontinuous, so that an effective shallow aquifer recovery system is not feasible. Contamination concentrations in the shallow aquifer outside the extraction line are also relatively low. Not only would the off site contamination be captured by the deep aquifer extraction system, but it can be treated as well, since the concentrations are low enough for the air stripper treatment system. Additionally, the extraction well line shown in figure 11 covers all locations downgradient of the location of contamination at the McGraw Edison Plant site, so that all contamination flushed into the shallow aquifer during the proposed enhanced soil flushing will be captured.

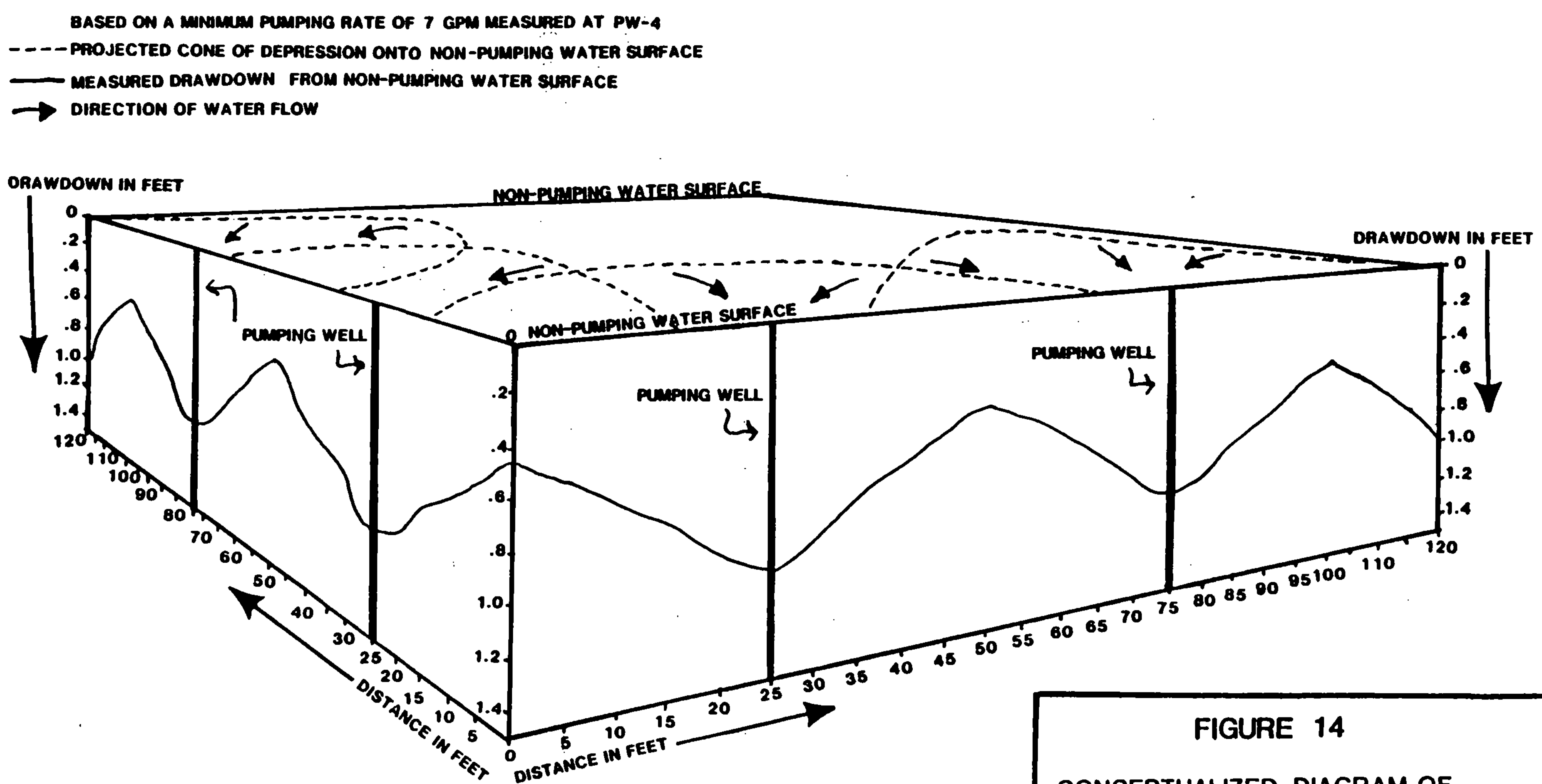

FIGURE 14

CONCEPTUALIZED DIAGRAM OF EXTRACTION SYSTEM PUMPING LEVELS

FRED C. HART ASSOCIATES, INC.

6.0 Conclusions

Volume 1 of this report (HART, 1986) provided detailed descriptions of site geology, hydrology, and the extent of contamination. This volume assesses the effectiveness of the current groundwater remediation systems now in use at the site. The assessment of the deep aquifer groundwater recovery system was performed with the use of three dimensional groundwater flow modeling. During the course of modeling, it was determined that the scale of the model was too large to predict the effects of pumping in the shallow aquifer. The shallow aquifer recovery system was, therefore, evaluated separately based on actual field measurements. The effectiveness of each remediation system is summarized separately below, followed by a brief discussion on long term groundwater monitoring.

Existing Site Conditions

The geology at the McGraw Edison Site consists of an upper glacial unit and a lower bedrock unit. The shallow glacial sand aquifer is separated from the deeper sandstone aquifer by a silty clay confining unit. In several remote areas, a few feet of high permeability outwash gravel can be found beneath the confining unit. Towards the Kalamazoo River, this confining unit disappears.

Flow in the shallow aquifer under natural conditions is generally toward the Kalamazoo River. Flow in the deep aquifer under natural conditions is generally to the Southwest or West, down the river valley. A downward gradient exists across the confining unit. In areas where the confining unit is absent, shallow aquifer water drops into the lower aquifer unit, and heads stabilize due to the unconfined conditions.

The extent of groundwater contamination in the shallow aquifer was documented. As expected, the areas of highest contaminant concentrations occurred downgradient of the areas exhibiting high soil contaminant concentrations. Contaminants flow generally to the South or Southeast. Due to the absence of the confining layer to the southeast, some contamination moves in that direction and is drained into the deep aquifer.

Contamination in the deep aquifer under normal conditions would probably have flowed to the west or southwest.

Assessment of the Current Deep Aquifer Remediation System

The current system for the remediation of the deep aquifer consists of a single pumping well on the McGraw - Edison plant property, called the "fire well". The fire well has the advantage of being near the center of contamination in the deep aquifer. It is a large capacity well designed to supply water at a rate up to 3,000 gpm. This well has been operated for a period of time as part of a deep aquifer groundwater extraction system. After extraction, the water is treated by an air stripping unit. A 4.3 million gallon per day, 5 parts per billion TCE discharge permit is currently in effect for the treated discharge.

To check the effectiveness of a single well extraction system, a three-dimensional finite difference flow model was used. Solute transport modeling was not used because of the low reliability of the model at low part per billion contaminant concentrations. Previous modeling efforts by other investigators produced results which were not acceptable to the MDNR for several reasons. Primarily, the extent of contamination was not known, and the quality of some hydrogeologic data was questionable.

After meeting with MDNR, the finite difference grid was established, acceptable boundary conditions and site parameters were input to the model, and the model was calibrated to conditions at the site. Several pumping schemes were developed which considered different extreme pumping conditions for the site. Results were checked against field measured values.

The field measurements and the groundwater model yielded similar results. It was shown that the furthest extent of the contaminant plume could be captured by the single pumping well (the fire well), even under the influence of the pumping Clark Street No. 2 well. The scenario simulating existing conditions indicated that the fire well could be pumped at a rate of 2,000 gpm with the Clark Street No. 2 well pumped at 1,100 gpm. Another acceptable scenario could be to increase the pumping rate of the fire well to 3,000 gpm. However, this may result in other adverse effects e.g. drying up springs.

The concept of a single, centrally located extraction well (the fire well) is acceptable for this site. This well is capable of capturing the extent of the deep aquifer contaminant plume. It was determined by field measurements that the radius of influence from this well reaches out far enough to capture any shallow aquifer contamination which is not captured by a shallow aquifer remediation system. Although the Clark Street Well #2 can be pumped without receiving contamination from the site while the fire well is pumping, existing monitoring wells should be tested to insure the continued presence of a groundwater divide between the site and the Clark Street well. Although the current 2,000 gpm pumping rate for the fire well is adequate to retract contamination, higher rates could provide faster remediation. The pumping rate in the fire well should be incrementally adjusted over the long term to attain the optimal pumping rate. Testing at monitoring wells and springs could be used to field calibrate the pumping systems and assure that groundwater divides would be maintained.

Assessment of the Shallow Aquifer Remediation System

The current system for the remediation of the shallow aquifer consists of a series of seven four inch extraction wells spaced on 100 foot centers near the segment A area. These wells are manifolded to a water main which carries contaminated groundwater to a carbon adsorption treatment system which is preceeded by a sand prefilter. Currently the system is operating at about 40 gpm, but has the capacity to treat up to 100 gpm.

Earlier in this study, an attempt was made to evaluate the effectiveness of this system. Several pump tests were conducted by previous investigators, however, the operation of the system was never checked to verify intersecting radii of influence from pumping wells. Preliminary field testing of this system indicated that a 100 foot spacing is not adequate to capture all contamination leaving the Segment A area. Furthermore, when the extent of contamination in the shallow aquifer was defined, it was discovered to be well beyond the lateral extent of the current system. In spite of these difficulties, it has been demonstrated that a properly designed shallow aquifer groundwater extraction system, when combined within the existing deep aquifer purge and treatment system will remediate the shallow aquifer.

Adequate well spacing is essential for an effective extraction well system. The line of wells will be placed near the edge of the confining layer where the contamination in the shallow aquifer drops into the deep aquifer. Well spacing was examined with the use of a shallow aquifer drawdown and recovery test at Purge Well 4 using four separate piezometers. A 25 foot radius of influence was found to be appropriate for this aquifer based on the rate of 7 gpm sustained by Well PW-4. Therefore, a 50 foot well spacing will overcome natural gradients and create a line of extraction wells that will prohibit the downgradient advance of contamination from the site. The lateral extent of the shallow well extraction system will cover the area of highest groundwater contamination, as well as the area directly downgradient of the proposed soil flushing areas. This approach will insure that con- tamination mobilized by soil flushing activities would be captured. The shallow aquifer extraction system will be protected against inadvertent releases of contamination by the deep aquifer extraction system safety net, which will also capture and retract existing residual contamination outside of the extraction well line.

Long Term Groundwater Monitoring

Long term groundwater monitoring will be necessary to monitor for the restoration of the aquifer systems at the site, using TCE as the indicator parameter.

The HART designed wells are suitable for use in a long-term monitoring program. Each well was designed for this purpose with a complete teflon sampling interval, which was accomplished with teflon screen, riser pipe, a teflon well Wizard Bladder Pump, Teflon lined discharge lines and a Viton packer assembly to seal the unit. This type of bladder pump insures that no air comes in contact with the sample, and the Teflon insures the long-term integrity of the samples.

The entire system of HART wells should be sampled on a quarterly basis. Over time, certain wells which consistently show acceptable levels of TCE will be removed from the sampling system. All monitoring activities will be reported in the quarterly report. Cessation of both extraction well systems would occur following the determination that each of the 25 monitoring wells and the treatment system had acceptable TCE concentration influent levels. Even if the deep aquifer is cleaned before the shallow aquifer, the deep well extraction system should not be shut off until shallow aquifer contaminant levels are reduced to acceptable levels.

Treatment Systems

Currently, the existing deep aquifer treatment system is permitted, operating, and functioning well. Although the current carbon adsorption system is adequate for the treatment of contaminated water from the existing shallow aquifer system, the increased rate at which larger shallow aquifer systems may operate could require redesign and repermitting of this system. Treatment system influent and effluent monitoring will be specified in the remedial design plan for the site.

Summary

The results of Volume I of the hydrogeologic assessment of the McGraw-Edison site in Albion, Michigan defined the geology, hydrogeology and extent of soils contamination in grondwater at the site. (HART, 1986). A previous report on the extent of soils contamination has also been completed (HART, 1986). This volume of the hydrogeologic assessment examined the effectiveness of the existing shallow and deep groundwater extraction remediation systems.

The existing fire well is adequate for the extraction of the contaminant plume in the deep aquifer. The fire well also will capture any stray contamination not captured by the shallow extraction well system. This determination was made through the use of a Three Dimensional Finite Difference Groundwater flow model and a field check of the results of pumping in the aquifer.

At a rate of 2,000 gpm and the Clark Street No. 2 well pumping at 1,100 gpm, the fire well was demonstrated in the field to have an adequate plume capture boundary. Operating the fire well at its maximum rate (3,000 gpm) will increase gradients and speed up aquifer restoration somewhat, but could result in adverse impacts on the aquifer. The existing groundwater divide must be maintained if both wells are to continue pumping. Any deep aquifer gradients could be controlled through incremental adjustments of pumping well rates, and field checked using water levels from existing wells and springs.

The existing shallow aquifer groundwater extraction remediation system is inadequate to capture the bulk of contaminated groundwater in the shallow aquifer at the site. However, any uncollected contamination is currently captured by the deep aquifer extraction system. Therefore, the deep aquifer extraction system should continue to operate as a key element of the shallow groundwater remediation plan, extraction system, even after the deep aquifer is remediated. Current spacing for the shallow aquifer system was demonstrated to be inadequate by field testing and backup calculations. A pump test was performed on purge well #4 with specially installed piezometers to collect information to determine the correct well spacings. As a result, it was determined that a 50 foot spacing will be needed to insure capture of all contaminated groundwater in the shallow aquifer before it can migrate off site.

The off site shallow aquifer contamination can be remediated with the use of the deep aquifer extraction system, since concentrations in those areas approximate those in the deep aquifer. The shallow aquifer system, however, will still need to be expanded to cover all areas downgradient of any proposed soil flushing activities.

Long term monitoring of the groundwater flow systems at the site is recommended. The 25 specially designed HART wells should be sampled quarterly for TCE. Sampling should continue until all wells show acceptable TCE concentrations. The deep aquifer extraction well system should be operated to remediate the deep aquifer as well as serve as a safety net for the shallow system until both aquifers have been restored.

6.0 References

Christner, M. 1982. GEOPLOT; c. Geoglobal Systems, Inc.

Fishbeck, Thompson, Carr and Huber, Inc. 1984a. "Groundwater Modeling at Aquifer Restoration for Albion, Michigan Plant Site." December 1984.

Fishbeck, Thompson, Carr and Huber, Inc. 1984b. Shallow Aquifer Pumping Test for Albion, Michigan Plant Site. September, 1984.

Fred C. Hart Associates, Inc. 1986. "Hydrogeologic Investigation of the McGraw-Edison Site, Albion, Michigan, Volume I."

Hamilton, D. 1986a. Meeting between R. Goldman (HART) and MDNR; Lansing, Michigan, May 22, 1986.

Hamilton D. 1986b. Meeting between T. Morahan (HART), D. Maddox (Cooper) and MDNR; Lansing, Michigan, April 23, 1986.

Hamilton, D. 1982. "Groundwater Modeling: Selection, Testing and Use." Task 20 of Groundwater Management Strategy for Michigan.

McDonald, M. and Harbaugh, A. 1984. "A Modular Three-Dimensional Finite - Difference Groundwater Flow Model," US Geological Survey Open-File Report 83-875.

Pinder, G. 1986. Meeting between T. Morahan (HART), D. Maddox (Cooper) and G. Pinder. Princeton, N.J. March 25, 1986.

Pinder, F. and Babu, D.K. 1983. "Review of Hydrogeologic Data Pertaining to Albion, Michigan Plant Site" prepared for Fishbeck, Thompson, Carr and Huber, Inc.

Powers, J. 1981. "Construction Dewatering." John Wiley & Sons, NY, NY. 484p.

Spinks, M. 1984. "IBM PC Compatible Version of U.S. Geological Survey Modular Three-Dimensional Finite-Difference Groundwater Flow Model." Microcode, Inc.

Wang H. and Anderson, M., 1982. "Introduction to Groundwater Modeling: Finite Difference and Finite Element Methods". Freeman and Co.